JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 17 MAY 14, 1936 No. 2

SUBSPECIFIC AND INDIVIDUAL VARIATION IN THE BURCHELL ZEBRAS

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It is a well established fact that in studying the systematics of mammals, and especially of large mammals, mere individual variation too frequently has been mistaken for specific or subspecific difference. Particularly is this true in the case of striped animals, like zebras, in which the color pattern varies not only in different specimens, but on the two sides of the same individual, for bilateral symmetry in external markings rarely is perfect. The interesting paper, by Miss Saint Leger (1932), on the synonymy of certain zebras of the Burchell group, conclusively shows that zoologists have gone too far in basing different so-called new forms on slight differences either in the number or the distribution of the stripes.

In this regard it is unfortunate that investigators in museums do not accord more weight to the insistence of hunters, explorers, and field naturalists with first hand knowledge of zebras, that it is impossible to find two zebras exactly alike, not only in the same locality but in the same herd. Many years ago, Buckley (1876, p. 282), in discussing South African zebras, said that "out of five of these animals shot in one herd there were individuals showing variation of color and marking from the yellow and chocolate stripes to the pure black and white, the stripes in some cases ceasing above the hock and in others being continued distinctly down to the hoof." Similar variability was noted by Major Stevenson-Hamilton (1912) 36 years later in the case of the Burchell zebra of eastern Transvaal. He reported that "some animals show heavy, wide, and deeply tinted shadow stripes, while others display only the slightest indications of them. Some are strongly ringed down to the fetlocks, while others have no signs at all of any markings below the knees and hocks. In some cases the body stripes are continued right round the barrel to the ventral stripe, in others they stop far short of it. The striping is usually carried right round the buttocks, but in I should say 20 per cent at least of the animals in each herd this is not the case. In fact there appears to be no special distinc-

tive marking common to any locality or even herd." His photographs very well corroborate these discrepancies, and show some others, no less noteworthy, in the relative width of the stripes, in the arrangement of those forming the "saddle," and in other details. One can see the same variation in the excellent photographs from life by Martin Johnson (1928). This well-known naturalist has tersely but very exactly described variability in the striping of zebras by comparing it to that of finger prints in man.

Notwithstanding these facts, there have been described nearly a score of species and subspecies of the Burchell zebra on the basis of such differences, most of them founded on single specimens, some on mutilated skins, and even on zoological park animals of unknown derivation, whose parents may have come from different countries. One can evaluate the validity of some of these supposed forms both by the difficulties encountered when attempting to identify specimens and by the arbitrary way in which the numerous names subsequently are employed by naturalists. As an instance of this, in Lydekker's Catalogue of the Ungulate Mammals, *Equus quagga böhmi*, *E. q. granti* and *E. q. cuninghamei* were accepted as distinct subspecies. The range of the last was described as extending "at least as far north as the northern flank of the Lorogi Mountains and southwards to the northern bank of the Tana." Then two specimens from near Lake Baringo, well within the latter range, were mentioned under the form *granti*, while "two pieces of skin" from Elmenteita, practically in the district where the type of *granti* was obtained, were identified as *böhmi*.

The superabundance of forms established for the Burchell zebra was criticized even in 1913 by Griffini in his compilatory hand-book Le Zebra. Yet, in his systematic résumé, this zoologist recognized no less than 12 subspecies and 3 varieties. Some years before, my attention was attracted to the subject by the publications of Allen (1909) and of Ridgeway (1909) on two very interesting series of zebra skins from East Africa, and I began collecting notes, sketches and photographs of zebras of the Burchell group either preserved in public museums or private collections, or living in zoological parks. I added to these the series of Allen, Ridgeway, and Stevenson-Hamilton, and all the available field photographs of explorers and naturalists. The data gathered in this way pertained to nearly 260 specimens, including the types of most of the alleged forms, and representing the whole range of the group from Abyssinia to the extreme south of Africa. I believe that the following analysis of all this material may be of some service in determining the status and relationships of the supposed species and races.

In order to facilitate comparison, I have adapted in each case the details of pattern on a conventional profile, thus avoiding the inconveniences both of deficient taxidermy in museum specimens, and of different positions in original drawings and photographs. Only a few of the specimens are reproduced in the present paper in order to make the text more intelligible.

In regard to the terms here employed, I call the dark areas "stripes," and the light ones "interspaces." The terms "dorsal band," "ventral band," "shadow stripes," "vertical stripes," "shoulder stripe" and "stifle stripe" are employed in the same sense as by Ewart (1901); but I consider that the "first cervical stripe" is not the transverse mark uniting the ears and going around them, as this author does, but the one immediately following this. Also, I call "oblique stripes" the bands of the hinder part of the body and quarters, designated by Ewart as flank stripes. Moreover, I name as "branched stripe" the one immediately after the last vertical stripe and anteriorly appearing as one of these, but showing in its upper part a more or less complicated ramification, the chief branch going over the croup towards the root of the tail. The branched part of this stripe forms the so-called "saddle," a feature peculiar to the Burchell zebras.

Before proceeding farther it must be stated that all the zebras of the Burchell group appear to me as comprising a single species, but one different from *Equus quagga*. Following Pocock (1902), many modern writers regard the former group as subspecies of *quagga*, and I have done likewise in previous papers, considering this last name as the extreme phase of stripe suppression. But in studying the cranial characters of Argentine horses (Cabrera, 1931), I compared a great number of skulls of different Equidae, and as a result it became evident that there are very noteworthy divergences between those of the true *quagga* and the *bontequagga* or Burchell zebra group. Some of these differences already have been remarked upon by Renshaw (1904, p. 189) and by Hilzheimer (1912, pp. 93–98). In its straight profile and its concave diastema behind the upper canine, the skull of *quagga* greatly resembles that of *Equus przewalskii*, while the skull of the Burchell zebra has an undulant or biconvex profile, somewhat as in the domestic ass, and its diastema is straight. The occipital angle (occiput-vertex angle of Osborn) and most of the indices of the skull of true *quagga* are more as in *E. caballus* than in the Burchell zebra. If one follow Motohashi (1930) and adopt Thomson's graphic method of correlation of the cephalic, craniocephalic, ocular and vomerine indices, the graph obtained for the quagga will prove to be very different from that for any zebra of the Burchell group, and rather similar to that for domestic horses. In my opinion such differences have a greater taxonomic weight than resemblances in coloration; but even these are more apparent than real. A well defined saddle, like that so characteristic of the Burchell zebras, never is found in quaggas. Furthermore, in the first, obliteration of the dark stripes always is accompanied by a corresponding intensification of the shadow stripes. Were *E. quagga* the extreme phase of the species, one would expect it to show well-marked shadow stripes; but, on the contrary, specimens of *quagga* with traces of these are very rare. Judging from photographs and pictures from life of the true quagga, it, indeed, was nearer *E. burchellii* in general aspect than to any other equid, and in the genus *Equus* these two

zebras must be placed in the same subgenus. In the striping (where stripes are present), however, most specimens of *quagga* do not resemble the Burchell zebras much more than the mountain zebras (*E. zebra*, *E. hartmannae*). The fact that a century ago the quagga and the typical Burchell zebra lived in the same region, between the Orange and Vaal rivers, but in separate herds and each associated with a different species of gnu (Harris, 1840), constitutes additional evidence against the possibility that they were only local forms of the same species.

The first technical description of a Burchell zebra was published by Gray (1825, p. 247) under the name *Asinus burchellii*. It was based on a skin sent by Burchell from South Africa to the British Museum. The locality given was merely "the flat parts near the Cape." According to Lydekker (1916[a], p. 22) the type locality should be "apparently the plains north of the Vaal River, in British Bechuanaland." Fortunately, one learns from Burchell himself (1825) that he shot his zebra in Little Klibbolikhoni Fontein, a locality situated in Latitude 27°50′ south and Longitude 24°25′ east; that is to say, not far from Taungs. I am indebted to Miss Jane Saint Leger for kindly verifying this important reference in the British Museum's library.

The type specimen of *Equus burchellii* no longer is in the British Museum, but its features are known from both the original description and the rather inartistic, but seemingly accurate, colored plate accompanying it. The ground color of the upper parts was said in the diagnosis to be whitish (*albicans*), but in the plate it is of a straw yellowish, very distinct from the white of belly, legs and tail. All the stripes are narrow, and those of the body terminate before reaching the midline of belly. There are 10 cervical stripes, one of them bifurcating upward and another downward. The shoulder stripe is represented only by its humeral bifurcation, after which there are 4 vertical stripes. The branched stripe has only 2 branches, the hinder one being parallel to the dorsal band and fusing with the 2 first oblique stripes. There are 4 of these, the second bifurcating on the croup, and the fourth constituting the stifle stripe. Below the last there is only a short trace of another mark crossing the thigh. After the third cervical stripe, every interspace presents a well defined shadow stripe. The limbs are entirely free of striping.

By the time that the type specimen reached London, a pair of Burchell zebras had been sent by a live-animal dealer named Cross from the Cape to the Jardin des Plantes at Paris. The female was described by Frederic Cuvier (1826), who gave a beautiful colored illustration of it. This specimen differed from that of Burchell in a few particulars. It had 9 cervical stripes, the shoulder stripe was complete, and several angular shadow stripes appeared inside its bifurcation. The fourth vertical stripe was broken at about the middle, its lower half fusing with the branched stripe, which really was not branched at all, as it had the posterior bifurcation only. The two first oblique stripes were united with this, and then followed a third oblique and a small

portion (the lower part) of the stifle stripe. Shadow stripes existed between the first 5 cervical stripes and between the oblique stripes, the other interspaces being devoid of markings; but a few of such evanescent marks were present on the thigh, behind the oblique stripes, and under the shoulder stripe, as stated above, and 3 short, ill-defined stripes appeared on the hock.

The figure of this female was reproduced in many popular books on natural history, including the well-known Dictionnaire of D'Orbigny. It also inspired a well-executed drawing by the British artist Stewart, published by Hamilton Smith (1841, pl. 23). In this the mare was accompanied by a foal adapted from the illustration of Cuvier. Incidentally, this last zoologist wrongly used for the animal the vernacular term "dauw" and the technical name *Equus montanus*, both of them given by Burchell (1822) to the mountain or common zebra.

According to Frederic Cuvier, the male of the same pair had on its thigh 2 more stripes than the female, and in it the shadow stripes were almost obsolete. This stallion very probably was the one figured in the 'disciples' edition of Georges Cuvier's Regne Animal (1839, pl. 83), obtained from Cross and then living in the Jardin des Plantes. In fact, Gervais (1842, p. 121) stated that the pair sent to Paris by this dealer still was living there 18 years later. The same specimen was said by Trouessart (1906) to be the one now in the gallery of mammals at the Paris Museum, which is very likely. The color pattern is not quite the same in the animal on exhibition as in the figure mentioned above, but they are rather similar in some particulars. Possibly the latter was made from a sketch. Both the illustration and the mounted specimen have numerous traces of stripes on the thigh and a few over the hock, and the shadow stripes are absent or very faint.

A great many zebras of this general type were received by European museums and zoological parks during the last century, invariably from the Cape. In 1845, the Earl of Derby had in Knowsley Hall Park a pair of zebras, a fine picture of which was made by Waterhouse Hawkins (Gray 1850, p. 76, pl. 15). As with the Paris specimens the female showed well-marked shadow stripes, even on the neck, whereas the stallion had barely a few traces of them. The pattern of the oblique stripes, although not similar, was very complicated in both animals. A few short stripes were present on the hocks of the male. Another specimen living in the London Zoological Gardens in 1887, and figured by Tagetmeier and Sutherland (1895, p. 51), had body stripes continuing more on the belly, some of them actually reaching the ventral band. The same was observed in 2 specimens formerly in the Dresden Zoological Park. A good photograph of one of these, a stallion living there in 1905, has been published by Lang (1924, p. 322), and of the other by Heck (Brehm, 1920, pl. 3, fig. 1). The latter had a few short streaks on the hock. Another zebra very similar to this specimen was in the zoo of the Natura Artis Magistra Society at Amsterdam some 30 years ago. Gregory has given its photograph

(1926, p. 118) under the name of Damaraland zebra (*Equus burchelli antiquorum*), but I can see no character of true taxonomic importance to distinguish these specimens either from the pair living in Paris a century ago or from the male painted by Waterhouse Hawkins. In fact, I regard as typical *burchellii* all the members of the species having all 4 legs white from the elbow and the stifle joint, except for the occasional presence of a few short markings across the hocks, and with the thighs free of complete and well-defined dark stripes behind the stifle stripe. The last may be absent also, as is the case in a female in the Mainz Museum, designated the type of a supposed subspecies, *E. b. paucistriatus* Hilzheimer (1912, p. 87, pl. 6, fig. 3). Judging by the variability of other races of the species, and by the fact that specimens showing these differences seem to have been secured in the same country, a more or less buffy ground color of the body, the greater or lesser extension of the body stripes toward the midline of the belly, and the presence or absence of shadow stripes, are features entirely devoid of systematic value.

This form of zebra appears to be extinct, the last specimen known being the one of which a photograph was published by Pocock in 1909 (p. 415, fig. 48). In its striping this individual greatly resembles the female illustrated by Frederic Cuvier; but it has no marks on the hocks. Unfortunately, as in most cases, its precise locality was unknown. In a posthumous work, Lydekker (1916[b], p. 122) described the range of typical *burchellii* as including Griqualand West and the Orange River Colony.

The Burchell zebras found north of these countries, from Benguela to the extreme west of South Rhodesia and to Zululand, differ from the typical subspecies in having the limbs striped at least as far as the vicinity of the "knee" and the hock, the stripes sometimes reaching the pastern joints. The oldest available name for this form is "*Hippotigris*" *antiquorum*, given by Hamilton Smith (1841, p. 327, pl. 22), who described it under the vernacular designation "Congo dauw," or zebra of Pigafetta, wisely suggesting that the animal "may be only a variety of the Cape dauw." The term Congo was used here in a too comprehensive sense, as the range of this zebra is said to extend from the Gareep (Orange) River to the Galla country. The name *antiquorum*, therefore, was employed originally for all the atypical zebras of the *burchellii* group. The specimen illustrated by Hamilton Smith is styled in the plate "Angola dauw," and the same name appears both in the index of the book and in the list of plates. Also, the old Bamba Kingdom, which was in Angola, is mentioned in the text as the country in which the animal is particularly abundant. I think it logical, therefore, to designate Angola as the type locality of this form, a zebra answering to the original description and figure of *antiquorum* really existing in that part of Africa (Lydekker 1916[a], p. 23; Blaine 1922, p. 332). The same subspecies later was found in Damaraland and Bechuanaland by Chapman and Baines, and named *Equus chapmani* by Layard (1865, p. 417), who regarded it as new. *Antiquorum* and *chapmani*,

indeed, generally were considered to represent different races, but their identity, as long ago suggested by Pocock (1897, p. 44), has been definitely settled by Saint Leger (1932, p. 592). According to this author the name *chapmani* may be reserved for the zebra of the hilly basin of the Zambesi, said by Baines to be somewhat different from the Bechuanaland race. This view now seems to me quite untenable. Layard's paper, in which the name *chapmani* (erroneously written *chapmanni*) was proposed, consisted of a letter by Baines addressed to J. E. Gray and accompanied by some "Notes on a supposed new variety of Quagga observed on the elevated flats between the Botletle and Zambesi Rivers." From its contents one learns that this "variety" was first encountered about 200 miles east of Walwich (Walfisch) Bay, during May, 1862, it having been recorded in Chapman's diary as new. In April of the next year a filly was shot in the high flats between the Botletle and the Zambesi, and its skin was sent to the British Museum. It arrived in a poor state of preservation and subsequently was destroyed, but it was described by Baines (pp. 421–422) as identical to the Damaraland form and different from that found in the Zambesi Valley north of Daka. It was to this actual specimen that Layard expressly referred in his letter to Gray, saying that he wished to name the animal *Equus "chapmanni."* Saint Leger's assertion that there was no skin on which to base this name, therefore, is not quite correct. On the contrary, there was a type specimen, although now lost, with a definite locality, and Schwarz (1912, p. 50) was correct in designating as the type the filly obtained by Chapman and Baines in the high Botletle flats of northwestern Bechuanaland. If, as Miss Saint Leger herself admitted, the zebras of this area are identical with those of Angola and Damaraland, I can find no reason for the separation of *chapmani* from the synonymy of *antiquorum*, and its assignment to another species.

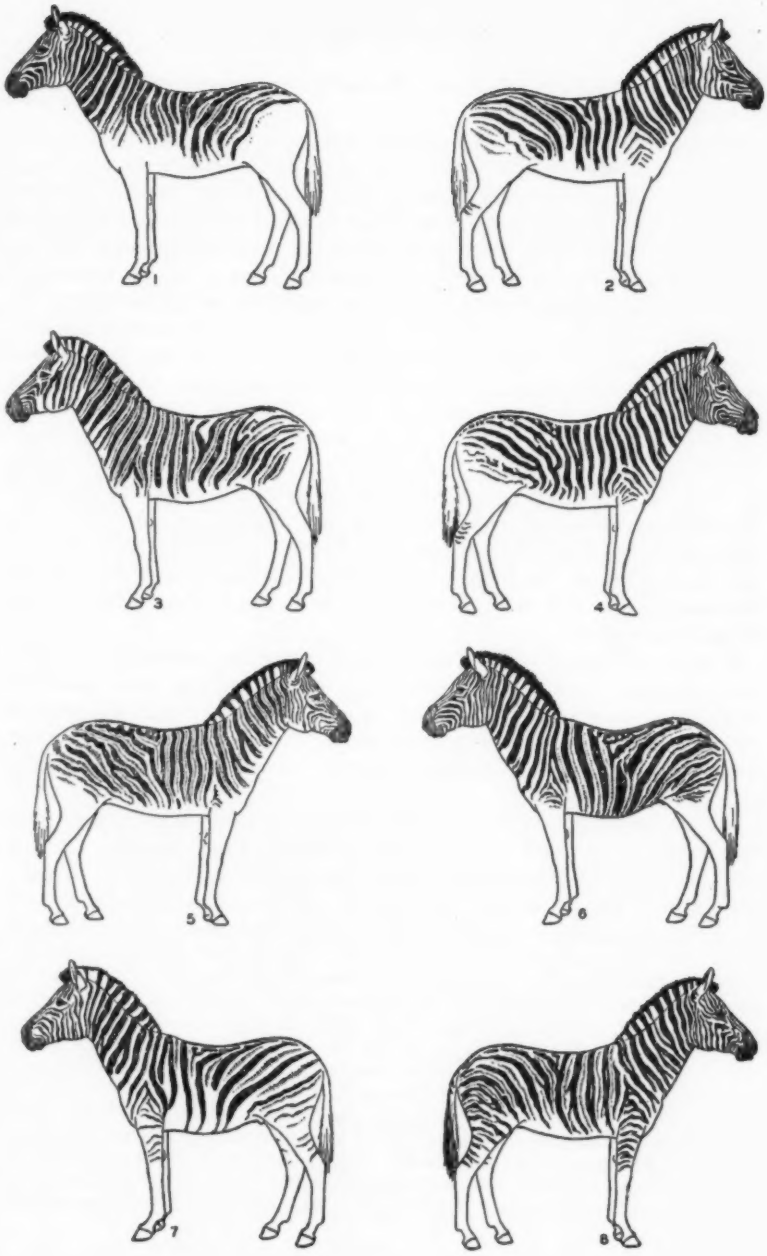
Apparently ignoring the true type of *chapmani*, Lydekker designated as such, or rather as a neotype, the figure published by Sclater (1865, pl. 12) and reproduced by many subsequent authors, of a female formerly living in the London zoo. This designation is somewhat faulty in the fact that the specimen, although exhibiting all the distinctive features of *chapmani* (*antiquorum*), came from an unknown locality, and neotypes must logically be topotypes in order to avoid the risk of local differences.

In my opinion the names *wahlbergi*, *transvaalensis*, *pococki*, *kaufmanni* and *kaokensis* also are synonyms of *antiquorum*. The last two must be regarded so on geographic grounds, *kaufmanni* having been based by Matschie (1912, p. 78) on an isolated head from the Caprivi, and the name *kaokensis* applied by Zukowsky (1924, p. 82) to a zebra from Kaokoveld. *Equus burchellii wahlbergi* is the name given by Pocock (1897, p. 44) to a zebra from Zululand, with chocolate brown markings, oblique stripes narrower than the interspaces, shadow stripes very deep and reaching forward to the withers, and limbs unstriped in the lower part. Buckley has stated, however, that both

black-striped and chocolate brown-striped zebras can be found in the same herd. Moreover, the type of *wahlbergi*, when described, had been on exhibition at the British Museum for a half century and its striping, doubtless, was much faded. The lack of stripes on the lower limbs is the distinctive feature of *antiquorum*. As for the other alleged subspecific characters, it has been shown by Stevenson-Hamilton that in the same localities in the Transvaal there are zebras both with broad and with narrow stripes, with evanescent as well as with intense shadow marks. Since the same variation has been stated by Saint Leger as characteristic of specimens from northern Damaraland, it seems natural that it may occur in Zululand also. Pocock (1909, p. 416, fig. 49) subsequently assigned to *wahlbergi* a specimen in which the oblique stripes are not much narrower than in the aforementioned female figured by Sclater, and regarded by all writers as *chapmani* (*antiquorum*). The neck is striped alike in both individuals, and the only noteworthy peculiarities of Pocock's animal are the presence of faint shadow stripes between the vertical stripes, the tendency of some of these to bifurcate, and the fusion of the markings on the thigh, as is to be seen in the photograph. All these features, however, happen to have been present in the type of *antiquorum*, as illustrated by Hamilton Smith. Furthermore, the last-mentioned feature has no importance, since Pocock himself informed us that the other thigh was normally striped.

Equus burchellii transvaalensis Ewart (1897, p. 622) was based on a female in the Edinburgh Museum, from northern Transvaal, and was described as very similar to *wahlbergi*, but with shadow stripes on the neck. Pocock mentioned some indication of these in the zebra he regarded in 1909 as *wahlbergi*, and several shadow marks also were present in the cervical interspaces of a female from west of Lake Ngami formerly living in the Madrid Zoological Park. From Stevenson-Hamilton's observations, as well as from the examination of a few specimens of *E. burchellii antiquorum* from any one locality, it is evident that the degree and extent of the shadow stripes has nothing to do with geographical distribution, but apparently these features are subject to individual variability. These markings start in the interspaces bordering the stifle stripe. They tend to develop forward on the body to the neck, and

FIG. 1. *Equus burchellii burchellii*. ♂, Mainz Museum. (Type of *paucistriatus*). 2. *Equus burchellii burchellii*. ♀, Jardin des Plantes, Paris, 1826. Adapted from F. Cuvier's plate. 3. *Equus burchellii burchellii*. Type, from Little Klibbolikhoni Fontein. Adapted from Gray's original plate. 4. *Equus burchellii burchellii*. ♂, Knowsley Park, about 1845. Adapted from a drawing by B. Waterhouse Hawkins. 5. *Equus burchellii burchellii*. ♀, Knowsley Park, about 1845. Adapted from a drawing by B. Waterhouse Hawkins. 6. *Equus burchellii burchellii*. ♂, Dresden Zoological Garden. Adapted from H. Lang's photograph. 7. *Equus burchellii antiquorum*. ♂, from Rietfontein West. Munich Museum. Adapted from E. Schwarz's photograph. 8. *Equus burchellii antiquorum*. Type, from Angola. Adapted from Hamilton Smith's original figure.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backward on the thigh to the hock. Scarcely any two specimens are the same in these respects.

Incidentally, *transvaalensis* evidently was used by Elliot (1907, p. 102) in the same broad sense in which I am using *antiquorum*, as he mentioned under that name several zebras coming from Middelburg, Transvaal, and one from Angola in the collection of the Field Museum of Chicago. It is to be noted that Elliot's figure accompanying this paper did not represent any one of these specimens, being merely an uncredited copy of an old drawing of typical *Equus burchellii* by Specht. In this regard it may be stated that one is unable sufficiently to censure the habit followed by so many authors of reproducing another's figures without proper credit. The practice, far from contributing to knowledge, easily leads the reader into error. As an instance, there is the nice drawing of a Burchell zebra in Edouard Foà's "Mes grandes chasses dans l'Afrique centrale" (Paris, 1901, p. 125). It is signed by P. Mahler, and from the list of illustrations one is informed that the drawings in this book were made "d'après les documents rapportés par l'expedition." The truth is that this figure is a frightful copy of a photograph from life by Gambier Bolton representing a specimen in the London Zoological Gardens (see W. H. Flower's The Horse, 1891, p. 87). The animal certainly was not obtained by Foà, and very likely did not come from a place visited by this French hunter.

A good photograph of the Field Museum specimens previously was published by Skiff (1902, pl. 21), and in this, one can see the same variability exhibited by Stevenson-Hamilton's series. Since shadow stripes appear to be absent on the neck of these zebras, one must conclude that Elliot called them *transvaalensis* not because of their character, but because most of them were obtained in the Transvaal.

Equus burchellii pococki Brasil and Pennetier (1909), is an almost indeterminable name, based on a museum specimen without locality. It may have been park-reared and even from parents of different subspecies. Trouessart (1910, p. 196, fig. 1) used this name for a zebra sold by Hagenbeck to the Jardin des Plantes, but otherwise with an unknown history. Griffini (1913,

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FIG. 9. *Equus burchellii antiquorum*. ♀, from eastern Transvaal. Adapted from Stevenson-Hamilton's photograph. 10. *Equus burchellii antiquorum*. ♀, from west of Lake Ngami. Madrid Zoological Park, 1902. 11. *Equus burchellii antiquorum*. From Zululand. Adapted from a photograph published by Pocock under the name *E. quagga wahlbergi*. 12. *Equus burchellii antiquorum*. ♂, from eastern Transvaal. Adapted from Stevenson-Hamilton's photograph. 13. *Equus burchellii selousii*. From Angoniland. Paris Museum. Type of *foai*. 14. *Equus burchellii selousii*. ♀, from the Tendo of Nyspindire. Rouen Museum. Adapted from a photograph published by Brasil and Pennetier under the name *E. b. zambeziensis*. 15. *Equus burchellii selousii* From Fort Jameson. Tring Museum. Type of *annectens*. 16. *Equus burchellii böhmi*. ♀, from east of Lake Naivasha. Bâle Museum. Adapted from a photograph published by Roux.

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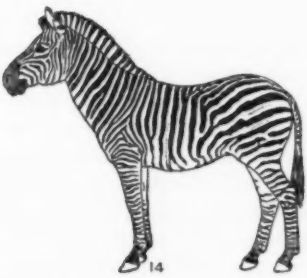
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p. 219, fig. 33) referred to the same alleged subspecies a specimen in the Rothschild collection at Tring of no less problematic an origin, and regarded by Pocock as typical *burchellii*. All these zebras agree in having limbs that are almost unmarked, with only a few stripes on the forearm and leg; but they may be regarded as representing an extreme phase of negative ornamentation in *antiquorum*. A specimen very similar to these, from Rietfontein West, preserved in the Munich Museum, has been described under the same name by Schwarz (1912, p. 46), and from the original figure of *antiquorum* there is evidence that the type of the latter form also had very few stripes on the limbs. Specimens exhibiting this peculiarity no doubt are very near typical *burchellii*, but that is only a natural result of geographic position. *Equus burchellii antiquorum*, in fact, is geographically intermediate between *E. b. burchellii*, with entirely white limbs, and the northern races in which the legs are marked to the coronet. One naturally expects to find in this transitional form every possible variation between these two extremes.

Among the photographic postcards of animals in the Paris Jardin des Plantes, published about 12 years ago by the firm of Moreau Fréres, there is one (numbered 261) of a zebra entitled Zébre de Potock, *Equus Potocki.*" I wonder if such a name, without a responsible author, is worthy of consideration in zoological nomenclature. It very likely is a lapsus for *Equus pococki;* but at all events the animal illustrated has nothing to do with the specimens described under this last name. It appears merely to be one of the hybrids between *E. burchellii* and *E. zebra* in the Parisian menagerie.

Judging by all the available material, zebras living in the Zambesi basin, from Victoria Falls, and between this river and the lower Limpopo (that is, south of Lake Nyasa, in Southern Rhodesia and the larger part of Mozambique), are distinguishable in having the limbs striped to the coronet, and the body with numerous narrow stripes and few and faint shadow stripes. The cervical stripes are 10 to 13 in number, a few of them at times being bifurcated, and behind the shoulder stripe there are from 4 to 8 vertical markings, all or most of them reaching the ventral band. The oblique stripes number 4 or 5. The interspaces, also very narrow, disappear on the pasterns, which are nearly or wholly black because of the fusion of the stripes.

It is my opinion that this is the form of zebra encountered by Baines and Chapman north of Daka in the Zambesi Valley, to which Saint Leger applied the name *chapmani*, apparently ignoring the fact that this originally was given to the race occurring southwest of Daka, and thence to Walfisch Bay. The oldest available name for the Zambesi form appears to be *E. burchellii selousii* Pocock (1897, p. 45), based on a specimen obtained by Frederick C. Selous on the Manyami River, in central Southern Rhodesia. Guillaume Vasse (1909, p. 139, pl. 13 and 17) found the same zebra in Mozambique, and he gave photographs of it under the names of zébre de Burschell [*sic*] and zébre de Wahlberg; but it is impossible to detect any difference in the animals

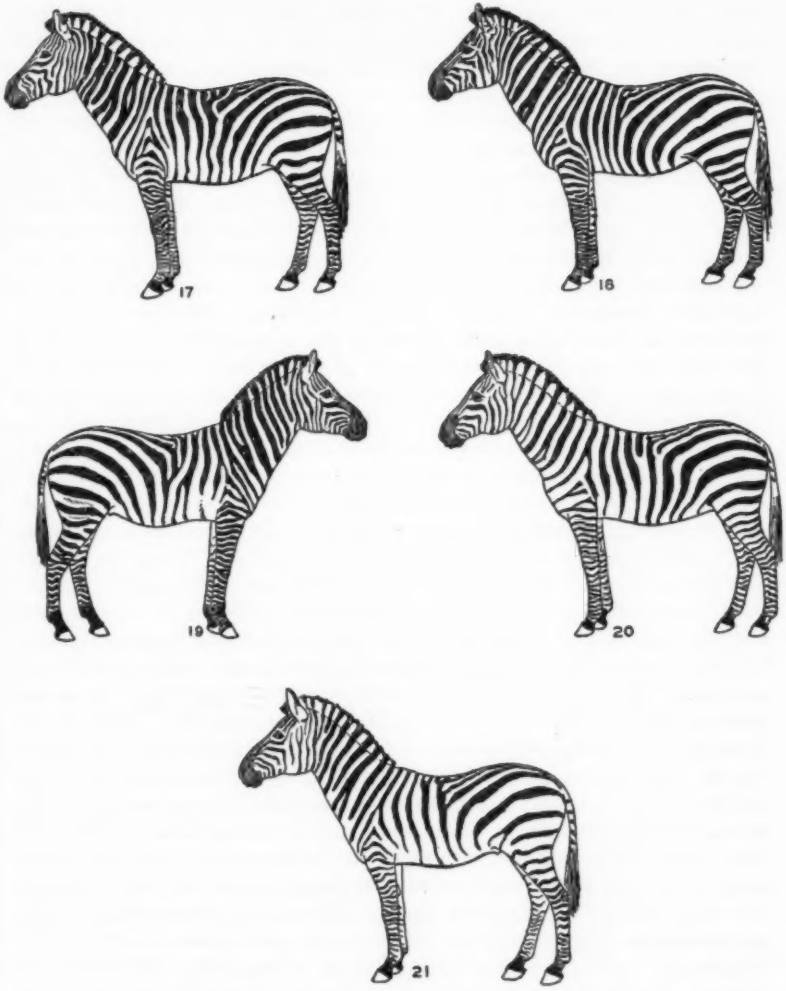

FIG. 17. *Equus burchellii böhmi*. From Marotseland. Type of *zambeziensis*. 18. *Equus burchellii böhmi*. From the Kilimandjaro district. Hagenbeck's Tierpark, Stellingen, 1905. 19. *Equus burchellii böhmi*. ♂, from southern Ethiopia. London Zoological Gardens, 1901. The same specimen as figured by Sclater in left side view. 20. *Equus burchellii böhmi*. From Masailand. Adapted from a photograph by C. G. Schillings. 21. *Equus burchellii böhmi*. ♂, from east of Lake Naivasha. Bâle Museum. Adapted from a photograph published by Roux with the name *E. b. mariae*.

accorded these denominations. Both have narrow stripes, very numerous on the neck, and wholly striped legs. Since this traveller said that he found the form *selousii* and the Wahlberg zebra together in the same localities, one safely can assume that he saw but a single geographic race. One of his specimens, shot in the Nyapindire Tendo, south of Pungwe River, now is preserved in the Rouen Museum and has been described by Brasil and Pennetier (1910) under the name *Equus burchellii zambeziensis*. In aspect and locality, however, it is quite distinct from the type of *zambesiensis*, mentioned below. Vasse's specimen, clearly, is the same race as illustrated in this author's photographs. It has some of the oblique stripes anteriorly united two by two.

Equus annectens Rothschild (1906, p. 691) seems to me inseparable from the last form. Its type locality, Fort Jameson in Northern Rhodesia, may be on the northern border of its range. Judging by a photograph given by Griffini (1913, fig. 18), the type differs from the zebras obtained in Mozambique in having rather broader stripes and correspondingly narrower interspaces. By comparison with other subspecies, however, I do not think that any systematic importance should be attached to this feature. Within the same general pattern, the opposite condition is found in the "zébre de Foà," or *Equus foai* of Prazak and Trouessart (1899, p. 350). The type and single specimen of this alleged species, preserved in the Paris Museum, came from the left bank of the Zambesi River, opposite Tete. Both on geographic grounds and from its characters it appears merely to be an individual of the subspecies inhabiting the basin of that river, and exhibiting the maximum of striping. In accepting *Equus foai* as a valid and distinctive species, authors have been misled by the original description and figure, both of which give an entirely false idea of the animal's features, as one can see from the photograph of the type published by Lydekker on two occasions (1912, pl. 19; 1916[a], p. 33). Trouessart's statement that this zebra lacks every trace of the "saddle" and has the branched stripe at the level of the hip, is untrue, even if justified by the drawing, in which the artist has made the body too short, thus altering the natural position of the stripes. From a comparison of my figure 13, in which I have endeavored to represent the pattern of this specimen as it really was in life, with Vasse's zebra from Mozambique (fig. 14), it may be seen that there is no reason to separate them even subspecifically. The greater number of stripes in Foa's animal is only an exaggeration of a feature that merely is peculiar to the Zambesian race of *burchellii*. The somewhat backward position of the branched stripe occasionally is observed in all the forms of this species. Ridgeway (1909, p. 556, fig. 149) has illustrated a skin from Kenya Colony with the same peculiarity, correctly considering it as subspecifically identical with the other zebras found in the same country.

Notwithstanding the many supposed species and subspecies based on the Burchell zebras inhabiting East Africa, from Ethiopia and the Bor district in Southern Sudan (Stevenson-Hamilton, 1920, p. 347) to Nyasaland and

northern Mozambique, I regard them all as one and the same race. They have limbs striped to the pastern, which is almost or entirely black, as in *selousii;* but the stripes on neck and body are less numerous and generally wider. There are from 7 to 10 cervical stripes, the most frequent number being 9. The vertical stripes number 3 or 4 (exceptionally 5, as in Ridgeway's specimen, with branched stripe very far to the rear), and the oblique stripes, not including the one on the stifle, number 2 or 3, one of them very rarely being bifurcated to form a fourth. Shadow marks almost always are absent, but if present are ill-defined and limited to the hind quarters. The ground color varies from pure white to pale buff, and the striping either is black or dark brown, these differences possibly being attributable, in some instances, to the condition of the pelage. I have seen in the private collection of the Marquis of Puebla de Parga at Madrid, a specimen from Kenya, secured midway between Lake Victoria and Nairobi, with changing coat. In the parts in which the hair is old and bleached, the ground color is cream buff and the stripes are sepia, while the new hair is clear white with black stripes. As noted by Allen (1909, p. 165), the color of the nose patch, sometimes regarded as of systematic value, also is very variable even in specimens from the same locality, varying from tan to dark blackish brown and being in some cases of both colors. In the Marquis of Puebla de Parga's specimen, the lips and the part between the nostrils are almost black, but the upper part of the patch is burnt sienna, this tint continuing for some distance on the face stripes.

This form of *E. burchellii* has been known for a long time. There is in the Victoria and Albert Museum of London a beautiful picture of it made in 1620 by the Moslem artist Nadir-al-Aor Ustad Mansur, with the indication that the animal was imported from Abyssinia by the Turks accompanying Mir Jufar. It was ignored by zoologists, however, until 1892, when Matschie described a skin from Pangani River as a new species, naming it *Equus böhmi.* Unfortunately, at a later date this naturalist (1894, p. 12; 1895, p. 95) gave the same name to a specimen living in the Berlin Zoological Garden that really was *E. burchellii antiquorum.* This change in the application of the name resulted subsequently in taxonomic confusion. The error was corrected by Matschie himself (1898), and was clarified afterward by Griffini; but in the meantime, under the delusion that *böhmi* was another animal, several new names were given the East African zebras. In 1896, De Winton described a specimen from Henga, west of Lake Nyasa, as *E. burchellii crawshaii* (later corrected to *crawshayi*), and named as *E. b. granti,* another from the Upper Tana, Kenya Colony. Almost immediately (1898, p. 3) the same author referred to a zebra from Machakes, in the last-mentioned district, as *böhmi.* For geographic reasons it should have been logical to recognize *granti* and *böhmi,* but De Winton preferred to consider that two different local forms occurred in the same district. In fact, *böhmi, crawshayi* and *granti*

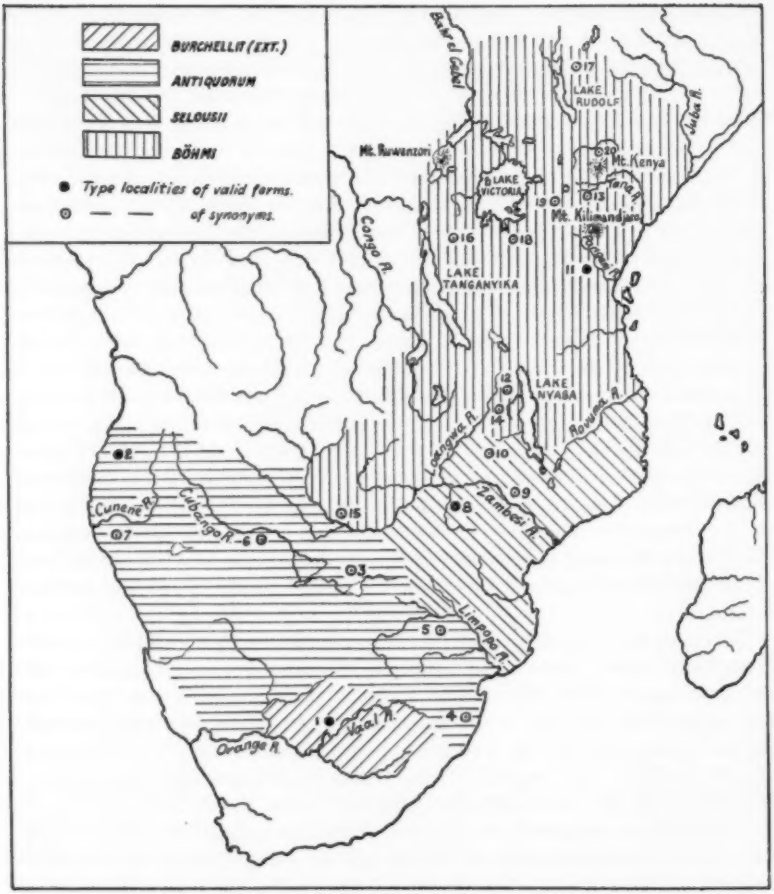

FIG. 22. Map showing distribution of subspecies of *Equus burchellii* and typical localities of names proposed. 1, *burchellii*. 2, *antiquorum*. 3, *chapmani*. 4, *wahlbergi*. 5, *transvaalensis*. 6, *kaufmanni*. 7, *kaokensis*. 8, *selousii*. 9, *foai*. 10, *annectens*. 11, *böhmi*. 12, *crawshayi*. 13, *granti*. 14, *tigrinus*. 15, *zambeziensis*. 16, *mariae*. 17, *jallae*. 18, *muansae*. 19, *goldfinchi*. 20, *cuninghamei*.

have been considered by many writers to be different forms. They appear to be so treated in Lydekker's Catalogue of the Ungulate Mammals, notwithstanding the fact that Matschie (1898) and Pocock (1907, p. 518) independently advanced the suggestion that *böhmi* and *granti* were synonyms.

This opinion was sustained by Lönnberg (1912, p. 125), and I also have employed the name *böhmi* (1925, p. 163) for all the zebras inhabiting the Kenya and Tanganyika areas. Finally, the absolute equivalence of the two names, *böhmi* and *granti*, unquestionably has been demonstrated by Saint Leger.

According to the latter's views, *crawshayi* is to be regarded as a distinct local form, but I can see no good reason for accepting her opinion on this point. Miss Saint Leger claimed (1932, pp. 590, 593) that *crawshayi* differs from *böhmi* in having comparatively narrower stripes; but she mentioned a specimen with narrow stripes from Zomba, south of Lake Nyasa, and another with stripes as broad as in *böhmi* from the same locality. In explanation of this discrepancy Miss Saint Leger assumed that these specimens, now preserved in the British Museum, were not actually native to Zomba, but were brought there from other localities. According to this assumption the skin with narrow stripes should have come from the highlands of northern Nyasaland, from which come animals of *crawshayi* type, while the broad-striped animal should have been obtained on the Nyasaland-Mozambique boundary, and thus belong to the subspecies *böhmi*. There is, however, no evidence of this difference in origin. Furthermore, it is highly improbable that in northern Nyasaland there is a hiatus in the range of the race *böhmi* of Kenya and Tanganyika, and that there its place is taken by another local form. I am quite willing to admit that the two Zomba specimens came from different localities and represent different forms. In this case, however, it would seem more logical to assume that the narrow-striped zebra was procured in the south and belongs to the race inhabiting the Zambesi basin, and that the broad-striped specimen, indistinguishable from *böhmi*, was secured in the north.

In a comparison of the original descriptions of *crawshayi* and *granti* (= *böhmi*), it is seen that De Winton based the alleged subspecific difference on 3 characters. In the type specimen of *crawshayi* (from Henga, west of Lake Nyasa) the stripes are of about the same width as, or slightly wider than, the intervening spaces. In the type specimen of *granti* (from Thika-Thika Valley, Upper Tana) the stripes are of a brown or chocolate color, the nose patch is lighter, and the oblique stripes are broader than the interspaces. It is seen from the foregoing that color of striping and of nose patch has no systematic value in zebras. In regard to the difference in the width of the stripes, this character is of importance only when it is so pronounced as to influence their number. In the series of skins from Kenya Colony described by Allen and by Ridgeway, there are specimens with the oblique stripes both broader and narrower than the interspaces, and of equal width. Noack (1902, p. 628) has described 6 specimens from the Kilimandjaro steppe, and thus practically topotypes of *böhmi*. Five of them have stripes broader than the intervening spaces, and the other has the interspaces broader than the stripes.

Further evidence of the lack of distinguishing features in the alleged sub-

species *crawshayi* is supplied by the uncertain and arbitrary manner in which authors employ this name. For instance, Gregory (1926) used this name with several photographs of two zebras, absolutely indistinguishable from *böhmi*, in the New York Zoological Park. In this same paper there is a splendid colored plate of the same two specimens labelled *Equus burchellii granti*, now admitted to be a synonym of *E. b. böhmi*. Loveridge (1923, p. 738) has used the name *crawshayi* for a zebra of northern Tanganyika Territory, not very far from the type locality of *böhmi* and within its range. Finally, Elliot gave the same name to a specimen from Beira, south of the Zambesi, on the Mozambique coast. In summary; it is my opinion that there is no good reason for considering the type of *crawshayi* to be subspecifically distinct from *böhmi*, that the specimens mentioned under that name in some cases are identical with the latter form, and in others belong to the narrow-striped Zambesian race for which *selousii* seems to be the valid name.

Equus tigrinus Johnston (1897, p. 292), from the country west of Lake Nyasa, generally, and quite rightly on geographic grounds, is regarded as a synonym of *crawshayi*. It falls, therefore, in the synonymy of *böhmi*. Noack has used *tigrinus* as the specific name for all the Burchell zebras of East Africa, and, furthermore, has considered those of Kilimandjaro to be identical with the Mashonaland animals, regarding them as the *Equus böhmi* of Matschie, although rather curiously calling them *E. tigrinus selousi*.

The type of *Equus burchellii zambeziensis* Prazak (Trouessart 1898, p. 64) is in the Paris Museum, where I have seen it and carefully copied its pattern. In all respects it is indistinguishable from *böhmi*, and it differs but slightly, in the width and general arrangement of the stripes, from a "Grant zebra" from Guashingishu, Kenya Colony, illustrated by Ridgeway (1909, fig. 153). The interspaces are cream white, practically without traces of shadow stripes, although it was stated by Trouessart that these are faintly seen in photographs. As already mentioned by this zoologist, shadow stripes are well defined in a foal in the same collection. The type specimen was shot by Emil Holub in Umwisi Valley, Marotsiland, on the northern bank of the upper Zambesi, above its confluence with the Linyanti. Another zebra, obtained in the same spot by the same traveller, is in the Vienna Museum, and was described as *Equus chapmani* by Lorenz (1894, p. 64), while a third specimen is preserved in the Budapesth Museum. According to Trouessart, the latter is, or was, exhibited under the name *böhmi*. Since there are no taxonomic grounds on which these specimens may be separated from *böhmi*, it is apparent that the range of this subspecies extends southward through the Bangweolo and Mweru regions to the upper Zambesi. It is noteworthy that in the original description of *zambeziensis*, Trouessart did not compare the type specimen with *böhmi*, nor with its synonym *granti*, but only with *crawshayi*. Furthermore, the specimen alluded to under this last name was not the type of *crawshayi*, but the individual later named *E. foai* by the same author.

Equus burchellii mariae Prazak (Trouessart 1898, p. 66) was described in a short diagnosis as resembling *crawshayi*, but with narrower stripes, chocolate brown nose patch, and dorsal band obsolete. The first two features are without systematic value. In regard to the third, Ridgeway's photographs of "Grant's zebras" give evidence that the dorsal band is very variable both in width and in longitudinal extent, almost disappearing in some instances. No type specimen has been mentioned for *mariae*, but the type locality was given as the country between lakes Victoria and Tanganyika. The fact that this supposed form is regarded as synonymous with *granti* (= *böhmi*) by some authors and with *crawshayi* by others, affords further evidence of the absolute lack of trustworthy characters for racial separation of all these zebras. Referring to the Burchell zebras in the Bâle Museum, Roux (1910, p. 925, pl. 7, figs. 3 and 4) has applied the name *mariae* to a specimen from east of Lake Naivasha, near the type locality of *granti*. Certainly it has very narrow stripes, but a blackish brown nose patch and a well defined dorsal band. Hence it presents only one of the three features originally assigned to *mariae* as distinctive. In addition, it came from a very different locality. Curiously enough, another specimen from the same locality has been regarded by Roux as *böhmi* only because it has broader stripes and presents a number of shadow stripes on the hind quarters. The same writer also called *böhmi* a zebra from Fort Hall, and regarded as *granti* another specimen from Kilimandjaro. There is no more significant instance both of the variability of the Burchell zebras of the same region, and of the arbitrary use by authors of the different names given to these animals.

The plate of a zebra sent to London from Abyssinia, to which Sclater (1902, p. 593, pl. 29) gave the name *Equus granti*, and the old picture in the Victoria and Albert Museum, show that the form inhabiting southern Abyssinia is *E. burchellii böhmi*. This animal, however, has been separated by Camerano (1902, p. 619, pl. 1) as *Equus jallae*. This name rightly has been considered by Roux as a synonym of *granti* (= *böhmi*), and Griffini regarded it as a "leve varietà." As pointed out by this last writer, *Hippotigris muansae*, based by Matschie (1906, p. 235) on a zebra head from the Duma River, southwest of Lake Victoria, also is indistinguishable from the common East African zebra. Matschie separated this "species" only because of some slight and valueless differences in the head striping.

Equus quagga, var. *goldfinchi* Ridgeway (1911), is so clearly an individual anomaly that it is hardly worthy of discussion. The original specimen, a skin from the Rift Valley, Kenya Colony, possibly is a case of partial albinism; but the large saddle-shaped white patch on the back may be of pathological origin. At all events, this specimen can not be separated from *böhmi*, because of the features of the rest of the skin and because of its locality.

Finally, Miss Saint Leger has shown so definitely that *E. quagga cuninghamei* Heller (1914, p. 3), from the Northern Guaso Nyiro, is identical with *E.*

burchellii böhmi that further consideration of this point is unnecessary. In all the original elaborate description of *cuninghamei*, there is no detail that cannot also be found in many other Burchell zebras from Uganda, Kenya and Tanganyika.

From the foregoing I conclude that all the alleged forms of the Burchell zebra, including *Equus foai*, described to date, may be reduced to four subspecies, easily distinguishable as follows:

a. Legs never wholly striped; shadow stripes generally numerous.
  b. Limbs without stripes below the elbow and the stifle, a few traces of them on the hock sometimes excepted.....*burchellii*
  b'. Limbs more or less striped below elbow and stifle, but never completely so.....*antiquorum*
a'. Legs wholly striped to the hoofs; shadow stripes very few and frequently absent.
  c. Stripes and interspaces on neck and body narrow and numerous; cervical stripes 10–13, vertical stripes 4–8.....*selousii*
  c'. Stripes and interspaces on neck and body wider and less numerous; cervical stripes 7–10, vertical stripes 3–4.....*böhmi*

The synonymy and geographic distribution of the four forms is summarized in the following:

Equus burchellii burchellii.

Zebra Burchell, 1822 (nec Linnaeus, 1785); *burchellii* Gray, 1825; *montanus* F. Cuvier, 1826 (nec Burchell, 1822); *zebroides* Lesson, 1827; *festivus* Wagner, 1834; *campestris* Hamilton Smith, 1841; *typicus* Selous, 1899; *paucistriatus* Hilzheimer, 1912.

Southern Bechuanaland and Orange River Colony (now extinct). Type locality: Little Klibbolikhoni Fontein.

Equus burchellii antiquorum.

Antiquorum Hamilton Smith, 1841; *chapmani* Layard, 1865; *wahlbergi* Pocock, 1897; *transvaalensis* Ewart, 1897; *pococki* Brasil and Pennetier, 1909 (in part at least); *kaufmani* Matschie, 1912; *kaokensis* Zukowsky, 1924.

From Benguela and Damaraland, across the Bechuanaland Protectorate, to Transvaal and Zuzuland. Type locality: Angola.

Equus burchellii selousii.

Selousii Pocock, 1897; *foai* Prazak and Trouessart, 1898; *annectens* Rothschild, 1906; *annectans* Lydekker, 1908; *zambeziensis* Brasil and Pennetier, 1909 (nec Prazak, 1898); *chapmani* Saint Leger, 1932 (nec Layard, 1865).

Lower Zambesi basin, from Victoria Falls; Southern Rhodesia; Mozambique; northward to southern Nyasaland. Type locality: Manyami River, Mashonaland.

Equus burchellii böhmi.

Böhmi Matschie, 1892; *crawshayi* De Winton, 1896; *granti* De Winton, 1896; *tigrinus* Johnston, 1897; *zambeziensis* Prazak, 1898; *mariae* Prazak, 1898; *selousi* Noack, 1902 (nec Pocock, 1897); *jallae* Camerano, 1902; *muansae* Matschie, 1906; *goldfinchi* Ridgeway, 1911; *cuninghamei* Heller, 1914.

Southern Sudan, east of Bahr el Gebel; south Ethiopia; extreme southwest Somaliland, west of the Juba; Kenya Colony; Uganda; Tanganyika Territory; northern Nyasaland; northern Rhodesia, to the upper Zambesi. Type locality: Pangani River.

Geographic distribution combined with individual variation within the same range indicate that racial difference in the Burchell zebra has little to do

either with altitude or with the fact that the animals inhabit grassy plains, park countries or deserts. Differentiation seems rather to depend on latitude, and in some cases rivers appear to act as barriers of distribution. Assuming that striping is an archaic feature in horses, the most primitive form should be that found in the lower Zambesi basin. Northward the stripes tend to be less numerous and both these and the interspaces become wider as though in compensation. The same fact is observed to the southward, but the character here is accompanied by a gradual obliteration of the stripes on the limbs and an increase in the number of the shadow stripes. A great river, the Orange, is, or rather was, the southern limit of the species. Another river, the upper Zambesi, divides the range of *antiquorum* from that of *böhmi*, and the lower Loangwa appears to separate this last from the range of *selousii*. East of this river, however, it seems that *böhmi* is found in the north, while the zebra living in the south belongs to the Mashonaland race, which is quite in accord with the difference found by Wroughton (1907, p. 1) in the mammalian fauna of that country.

There are, of course, specimens that are intermediate between geographically adjoining races. For instance, the type of *annectens* seems to be an individual of *selousii* verging toward *böhmi*; and some specimens of *antiquorum* with limbs almost unstriped are very near typical *burchellii*. In addition, Stevenson-Hamilton has shown a photograph of a specimen of *antiquorum* that very much resembles *selousii*, but with fewer stripes on neck and body. These transitional specimens attest the unity of the species, but I think it both unnecessary and inadvisable to give to each a distinctive name, especially since no two zebras are entirely alike.

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RECENT JACK RABBIT POPULATIONS AT RAPIDAN, MINNESOTA

BY W. P. MOHR AND CARL O. MOHR

White-tailed jack rabbits, *Lepus townsendii* Bachman, were particularly abundant at Rapidan, Blue Earth County, Minnesota, during the winters of 1933–34 and 1934–35.

Interest regarding fluctuation in the numbers of these mammals led the writers to assemble the data secured from time to time during the last 17 years. Although scanty, they are sufficiently complete to demonstrate that populations at Rapidan may range from a few to more than 69 hares per square mile, but the most usual number falls between 10 and 20. These estimates are recorded as large numbers upon the lower right of yearly climographs (fig. 1), prepared from Weather Bureau records (Climatological data for the United States by sections: Minnesota section) which indicate that growing seasons were dry during those years in which hares were abundant and wet when they were less numerous. Rainfall data are from Mankato, 6 miles northeast of Rapidan, and temperature data from St. Peter, 17 miles northeast.

Estimates of populations are based on the following observations and methods. During August 1917, the junior author saw 3 jacks regularly flushed by dog from a clover patch on a farm of 160 acres, and estimated the population at about 12 individuals per square mile. Although weather data for the region under consideration are too incomplete for the construction of a climograph for 1917, they indicate that the growing season in that year was about normal in spite of May, which was wet, with 5.88 inches of rain.

During the next year, 1918, no jacks were flushed from this farm, summer or winter, although the clover acreage had been increased threefold. Precipitation during the growing season was excessive (fig. 1, 1918). The number of jacks must have been small.

More random data were gained while cruising and hunting during later years. When one man cruised alone he considered average flushing distance to be 5 rods to either side (a total of 10 rods). When 2 or more cruised they remained about 8 rods apart. Their frontage was considered to be 18 rods, while frontage for 3 was 26 rods, and for 4, 34 rods. Pasture and woodland were avoided; otherwise the cruising was done at random. Care was taken to avoid areas shot over earlier in the hunting season. Late in November,

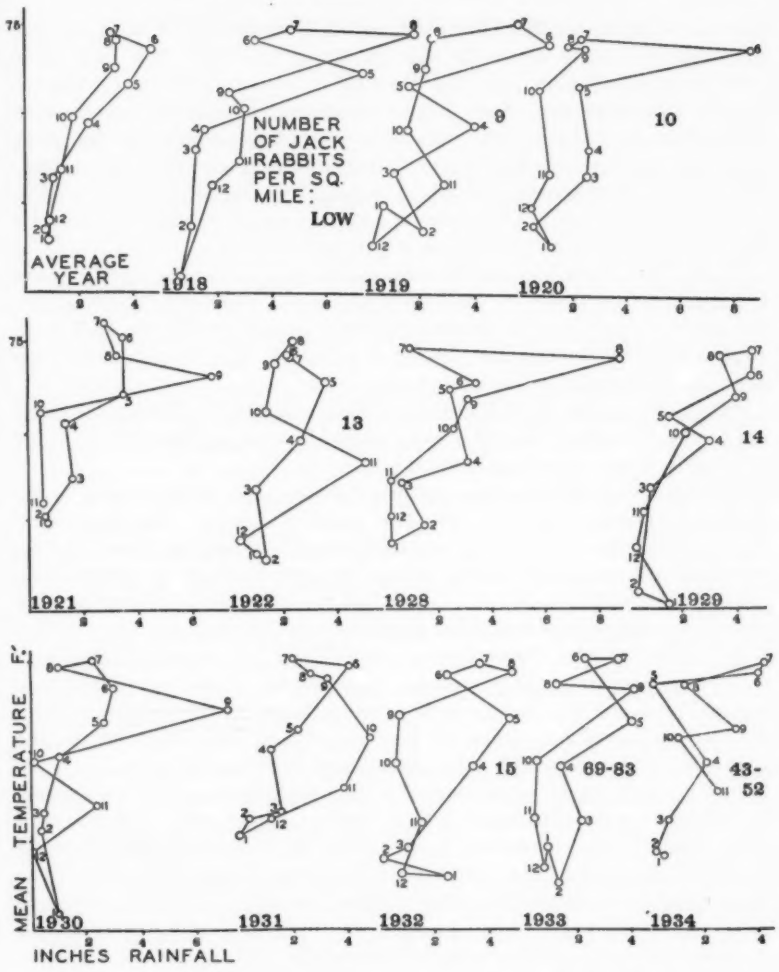

FIG. 1. Yearly climographs based on mean temperature and total rainfall, by months. Figures on lower right of climographs are yearly estimates of jack rabbit populations per square mile.

1919, one man cruised a distance of 1.8 miles and flushed one jack. Early in December, two cruised 1.7 miles and flushed one. On December 25 one cruised 1.9 miles but flushed none. The estimate is about 9 jacks per square mile.

In December 1920, one man cruised 2.9 miles and flushed one, yielding an

estimate of 10 jacks. During the last week in December, 1921, a competitive hunt was held with about 50 men participating. Only two jacks were brought in, as compared with more than 120 cottontails, *Sylvilagus floridanus* (Allen). Although this affords neither an accurate population ratio between the two species, nor a basis for estimating populations, it indicates that jacks were not common. Each jack contributed twice as many points as a cottontail, yet jacks were too unprofitable to be sought for the purposes of this hunt.

Late in December, 1922, a party of 4 men cruised 2.2 miles and flushed 3 jacks, yielding an estimate of about 13 per mile.

During July, 1929, the junior author again spent some time on 80 acres of the farm mentioned under date of 1917 and 1918. Here, after working over the ground thoroughly, he flushed 2 jacks. During December, 1929, both writers cruised 2.7 miles and flushed 2 jacks. It was estimated that the population per square mile was about 14.

Late in November, 1932, the senior author cruised 2.5 miles and flushed 2 jacks. On December 25 both writers cruised 2 miles and flushed one. The estimate is about 15 jacks per square mile.

In December, 1933, the senior author and 4 others hunted thoroughly over a 30 acre plowed field northwest of town, and shot 3 jacks. During the first week in November they hunted over a 25 acre plowed field northwest of town and flushed 9, giving an average of one jack per 4.6 acres of plowed land. Between 50 and 60 per cent of the land was plowed. The estimated number of jacks was between 69 and 83 per square mile.

In November, 1934, 3 men cruised over a 45 acre field of plowed land south of town and flushed 5 jacks, and one man cruised 13 acres of plowed land north of town and shot 3: an average of one jack per 7.3 acres of plowed land. Between 50 and 60 per cent of the land was plowed again this year and the estimated number of jacks was between 43 and 52 per square mile.

Only once during previous years were data taken from plowed land alone. In 1922 the party of 4 cruised 2 fields aggregating 40 acres, and flushed 2 jacks. Since jacks concentrate upon plowed land during ordinary winters results of this cruise indicate that there were at least 16 per square mile. The figure approaches that obtained by random cruising in the same year, and indicates that estimates based on random cruising and those based on cruising of plowed lands are safely comparable within the requirements demanded by our conclusions. We may state, therefore, that during the last 2 seasons jacks were many times more abundant than usual.

Even greater numbers of this species have been recorded by Bailey (North Am. Fauna no. 49, p. 144, 1926). His data yield an estimate of at least more than 277, and possibly in excess of 351, per square mile for western Hettinger County, North Dakota, during a period of exceptional abundance in December, 1924.

Rapidan, Minnesota, and State Natural History Survey, Urbana, Illinois.

OBSERVATIONS ON THE KAMCHATKAN BEAR

By Sten Bergman

There probably is no part of the Palearctic Region where bears are more numerous than in Kamchatka. The chief reason for this circumstance probably is the fact that in this peninsula the food supply is extremely abundant. During the summer and autumn the rivers swarm with salmon, which move up the streams to spawn in almost incredible numbers, and it is this fish which constitutes the chief article of bear food. The small population of the country and the difficulty of travelling through it also are contributing factors. Bears can not successfully be pursued in summer through the trackless thickets of dwarf pine (*Pinus pumila*), alder, and shrubbery exceeding the height of a man.

During my stay in Kamchatka, from 1920 to 1922, I had numerous opportunities for becoming acquainted with bears. I met them frequently during my excursions and was able to learn much regarding their habits.

In the earliest documents concerning Kamchatka one finds mention of the abundance of bears. Steller (Beschreibung von dem Lande Kamtschatka, Frankfurt und Leipzig, p. 113, 1774) wrote "Schwarze Bären . . . hat man auf ganz Kamtschatka in unbeschreiblicher Menge, und siehat man solche Heerdenweise auf denen Feldern umher schweifen." Since that time all travellers in the country have been struck by the fact.

The Kamchatkan bear (*Ursus piscator* Pucheran) occurs throughout the peninsula but is less abundant in the vast pine forests of the central districts. As much of its livelihood is derived from the streams the animal is most numerous in well watered areas, particularly along the tributaries of the larger rivers. Ditmar (Reisen und Aufenthalt in Kamtschatka in den Jahren 1851–55, vol. 1), who lived in Kamchatka from 1851 to 1855, traversing the greater part of the country during his stay, found that bears were very numerous along the east coast, especially near the rivers Shupanova, Berjosovaja, and Semjatschik.

The abundance of bears in different parts of the peninsula also is connected with the distribution of the population. In South Kamchatka, for instance, which is uninhabited except for the strip of coast lying along the Sea of Okhotsk, bears still are extremely numerous. During my journeys in the summer of 1922 along the east coast of South Kamchatka, I met with bears almost every day, and sometimes I saw from 6 to 8 a day. The animals were remarkably numerous in the tracts around Listvenitschnaja Bay. Along the western coast of Kamchatka, a region of many rivers, bears also are very common. Another district where bears are unusually numerous is the country around Lake Kronoki. Hunters also state that they are very common north of the River Kamchatka in the northeastern parts of the country. Their occurrence in the various districts, however, is subject to great varia-

tion. In tracts where they are common during some years, they are quite rare in others. This circumstance generally is connected with the supply of fish, which is variable. When salmon are scarce the bears make extensive migrations in order to reach more favorable fishing grounds.

Kamchatkan bears usually leave winter quarters during the first part of April. According to the statements of native hunters they do not leave the dens before April 7. But my friend and companion during the Swedish Kamchatka Expedition, Rene Malaise, who has resided for 9 years on the peninsula, tells me that very few bears are abroad as early as that date. Those encountered usually are animals which are ravenous for food; but normally, they remain in winter quarters for some time longer. The earlier the spring, of course, the sooner they leave their dens.

At first bears like to lie and rest in the sun outside the dens, and then they undertake only short trips. I encountered a den on the slopes of Koselskaja Volcano, April 21, 1922. From this, upon the approach of my dog team, there rushed a bear. Marks in the snow showed that the bear had lain outside his lair, and had made repeated, short expeditions on the nearby slopes. It was evident that the animal had been greatly terrified by the appearance of my team, for his tracks, which I followed for about a mile, ran as straight as an arrow. At that time the ground was entirely covered with snow.

After the bear has left winter quarters, it usually wanders among the mountains, which are then covered with snow. It seems that at that period he takes no food, but is nourished chiefly by his own fat, some of which remains at that season. I once saw a layer of fat some centimeters thick from a bear that had been shot at its den in March, and hunters say that, as a rule, the bear has not lost the whole of its supply of fat when it leaves its winter dwelling.

As a change from trips among the snow-clad hills, the bears that live near the coast go down to the shore to search for something to eat. Seaweed then is consumed, and probably dead fish.

Before the hills become green, willow catkins are eaten with the greatest relish. Hunters agree that these catkins play a great rôle in the spring-time food of the bear; one frequently sees willow bushes, stripped of their catkins, surrounded by bear tracks.

As soon as the earliest verdure is visible bears hasten to such spots and graze upon them daily until the salmon make their appearance in the rivers. As a change from the green fodder, which appears to be a chief source of sustenance during the latter part of the spring and the beginning of summer, small rodents are caught at every opportunity. In the stomachs of bears shot along the east coast of South Kamchatka (Achomten Bay and Listvenitschnaja Bay) during the first part of June, 1922, I found mostly green plants, as well as the remains of *Arvicola* and *Ochotona*. Malaise, in the autumn of 1921 at Kronoki, observed a bear engaged in catching small rodents. The bear was

eagerly scratching up the ground, and making ungainly jumps here and there after the voles. On heathland one not infrequently sees patches where moss and berry bushes have been cleared away by bears in pursuit of such prey.

In the spring, before the salmon have ascended the rivers, bears are prone to seek marshy tracts for the nests of wild ducks. I had no opportunity of observing this myself, but hunters have assured me of the fact, and that sometimes in spring they go bear hunting to the marshes with prospects of success.

During the entire spring, however, bears await the salmon runs. When this time approaches the animals gather from all quarters and seek the streams. They know quite well the places where the fish come earliest, and there the bears assemble in great numbers. At first they are extremely hungry, and then they can be found by the water at all times of the day, eagerly bent on fishing.

Methods of catching the salmon vary. If the river be very shallow the bear wades in and catches the salmon by seizing them with his teeth. On such occasions there are long and clumsy jumps in the shallows, with much splashing, as the terrified fishes are followed. Sometimes the bear stands in the river watching for the fish as they swim along, a thing which I had the opportunity of seeing in South Kamchatka in 1922. On other occasions, he lies in wait with a great part of his body hidden beneath the surface. Ditmar relates how once he saw two bears squatted so deep in the water that nothing but their heads were visible.

At Lake Assabatsche, Malaise saw a bear swim from the shore and, after going some distance, dive and disappear. He soon reappeared with a salmon, which he at once carried to the shore and devoured. At the spot where the bear dived, there are springs which issue from the bed of the lake, and there the salmon gather in large numbers. The water is as clear as crystal, and the spot is a favorite fishing ground of the bears. The natives, knowing this, even have built a shooting-platform there, from which they hunt the fishing bears. When travelling along the rivers, one not infrequently encounters one or more swimming bears, and their cleverness in the water is marked. At Kronoki, Malaise saw a she-bear with two cubs swim several miles, from one point of the lake to another. Ditmar told of a wounded bear casting itself into the sea and, despite high waves, swimming for about an hour, after which it landed at a spot far distant from its starting place.

When the salmon are abundant, the bear devours nothing but a small part of the fish, frequently only the head. In consequence, where these fish are plentiful, one can always see partly eaten salmon on the banks.

Having ended his meal, the bear goes to sleep near the water. On such occasions, he loves to rest in the dense beds of *Filipendula kamtschatica*, taller than a man, which often grows luxuriantly along the river banks. The bears have their paths running through the close vegetation, and there the natives hesitate to follow them, for a man soon is hidden by the plants. If

they do so venture, they first shout or make some other noise in order to be sure that a bear will not be taken unawares, for on such occasions the animal frequently attacks the intruder. The bear also likes to sleep in the alder thickets near the river. In such a place I once aroused an animal lying only a few yards in front of me.

From this time of the year until late autumn salmon constitute the chief food of the bears, but in the month of August, when the berries begin to ripen, the animals desert the rivers for a time in order to eat berries. The earliest berry is the "shimolost" (*Lonicera coerulea edulis*), which ripens at the beginning of August. In certain parts of the country there also is found the red currant (*Ribes triste* and *Ribes latifolium*), likewise a favorite food of the bear. A bear that I examined, shot in August close to the River Kamchatka, had a mass of this fruit in its stomach. The bear devours all kinds of berries, but is especially fond of the crow-berry (*Empetrum nigrum*), which grows luxuriantly on the moors. He also likes the cloudberry (*Rubus chamaemorus*), the great bilberry (*Vaccinium uliginosum*) and the red whortleberry (*Vaccinium vitisidaea*). In September and October, the mountain-ash (*Sorbus sambucifolia*) ripens and its fruit, which in Kamchatka is very sweet and grows on low bushes, within easy reach of the bear. During the months just mentioned this constitutes a very important part of the animal's food. In October (1920) droppings of the bear, near Lake Nerpitsche, contained little else than the remains of mountain-ash berries.

Another source of autumn nourishment much appreciated by the Kamchatkan bear is the seeds of the dwarf pine (*Pinus pumila*). This bush is found in limitless quantities, clothing almost all the mountain slopes. In the stomach of a bear shot in the autumn many of these seeds often can be found. Malaise once had the opportunity of observing from a short distance the method employed by the animal when eating these seeds. The bear stood on its hind legs against a bush and with its forepaws drew down the branches, taking in its mouth one pine-cone at a time. Then, with its teeth, it separated the seeds from the scales. The latter flowed out from each side of the bear's mouth in a steady stream, the animal's jaws being in lively movement. Malaise observed this at a distance of about 50 yards with the help of a Zeiss field-glass, so that every detail could be followed clearly. Late in the autumn, when the salmon have left the rivers, the berries of *Empetrum nigrum* and *Sorbus sambucifolia*, and the seeds of *Pinus pumila*, often constitute the bear's principal food.

Winter quarters are sought in the month of October, the exact date depending partly upon the mildness or severity of the weather, and partly upon the food conditions during the autumn. If the latter have been favorable, and the bear has grown fat, he retires to his den at an early date. If the animal still is thin, he may delay retirement for a long time. According to the statements of hunters, all the bears that wander abroad at a date later than that of normal hibernation, are thin. The hunters believe that such animals

do not survive the winter. In exceptional cases a few bears can remain afield into the month of December, in spite of deep snow, staying in the vicinity of springs which do not freeze over, and in which fishes (*Oncorhynchus kisutch*) are plentiful.

The bear usually chooses for his winter quarters some place among the thicket-clad and inaccessible steeps of the mountains. Consequently one seldom discovers dens, as they are covered with deep snow in the winter and hidden by the tangled vegetation in summer.

A den that I found in a thicket-covered steep on the slopes of the Koselskaja Volcano was discovered when the occupant rushed from it at my approach. The ground still was covered with snow. The den had been dug by the animal, and had its opening toward the south. Another winter den just had been deserted when I found it in April, 1930, on the island of Yeterofu, one of the Kuriles. It also had the opening toward the south. The latter den was very similar in shape to the dens from Hohkaido, described by Tnukai (Trans. Sapporo Nat. Hist. Soc., vol. 12, p. 175, 1932).

As a rule, the Kamchatkan bear does not attack man, but usually takes to flight as soon as he detects a human being. Even she-bears with young ones generally flee, unless the cubs are very small and seem unable to escape. But if a bear be surprised at close quarters and fears that he will be unable to save himself by flight, he often turns and attacks the intruder. Persons not rarely have been killed in this way, and during my journeys I saw several people who had been maimed by bears.

The animal is most dangerous in the spring and late autumn, when food is difficult to secure, and at such periods the natives dare not go alone after dark in tracts frequented by bears without shouting or making some other noise. At these seasons the bears not uncommonly seize horses and cattle upon the outskirts of villages, a thing which even today takes place every year. Otherwise, the Kamchatkan bear is a very peaceable beast, this undoubtedly being due to the ease with which he usually can obtain food, so that more savage instincts have not become developed to any great degree.

The color of the Kamchatkan bear varies considerably. I have seen individuals that were perfectly black, others that were yellowish white, and animals of hues between these extremes. A very common color is light brown; but there are all shades of that tint. The extremely light color of some of the bears makes them appear at a distance almost white. In size the Kamchatkan bear usually resembles the bear of northern Europe, but really gigantic specimens sometimes are seen. In the autumn of 1920 I was shown in Ust-Kamchatsk a pelt which far surpassed in size every other bear-skin I have ever seen. It was perfectly black and short-haired. It is asserted generally by the hunters that the very largest bears always are quite black. Besides this they always are short-haired, in contrast to the animals of normal proportions, which in general are very long-haired.

Malaise has told me that on one occasion he saw the skull of a gigantic bear

of the black kind; its teeth were perfect, and hence it could not have been that of an aged individual. On another occasion he also measured and photographed a bear's foot-print that was 37 cm. long and 25 cm. broad, so that the animal must have been a veritable giant. There is much, then, that speaks for the existence in Kamchatka of a quite black, gigantic bear, in addition to the ordinary brown type; but this question must remain an open one.

The number of cubs in a litter seems to vary in Kamchatka between one and four. I myself have seen she-bears with as many as four young ones, and I have never heard hunters speak of a greater number. Two probably is the usual number. Of some ten yearling cubs that I have seen taken out of dens by native hunters, all have had a white ring around the throat, and in general they have been of a very dark, almost black color. This hue evidently grows lighter with increasing age, for of all the two- and three-year old bears that I have seen, none has been black, but all more or less brown.

It is very seldom that one sees small cubs during the earlier part of the summer. The mother then keeps herself and the cubs out of sight, probably in tracts very difficult of access, so as not to expose her young to danger before they are able to flee with sufficient speed. Hunters agree that if the male meets the cubs while they are still small he kills them.

Along the banks of all the Kamchatkan rivers there are well-marked bear-paths. These are not confined to the river-banks, however, but criss-cross the country in all directions, and Ditmar has pointed out that the bear always chooses the most logical places for traversing morasses or mountains. These paths are of great service to the traveller, for there exist in that desolate land no other roads between the sparsely scattered villages.

The Kamchatkan bear plays an important rôle in the domestic economy of the inhabitants. Its dense and warm pelt is used as a bed, and of its summer skin the natives make their reins, shoe-soles, and dog-traces. The meat is much appreciated as an article of food, and the gall-bladder, with its contents, always is preserved to be employed medicinally. In the more remote parts of the country the intestines still are used instead of glass, and the fat pads of the paws make a dish that cannot be surpassed.

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NOTES ON THE MAMMALIAN FAUNA OF UMZUMBE VALLEY, NATAL, SOUTH AFRICA

By Raymond B. Cowles

The following data were collected during a stay of 18 months in the Umzumbe Valley, where the writer was engaged in procuring detailed information regarding the life histories of certain birds and one reptile, the Nile monitor. While continuing this work, especial efforts were made to obtain as complete an understanding of the vertebrate fauna as possible, and it was in the pursuit of this objective that the present data were accumulated.

South Africa is an exceedingly large territory and while the topography and possibly the smaller mammals will remain unchanged for many decades, some of the sections, notably those in the less desirable locations that have been allotted to the natives, are undergoing a process of rapid alteration, because of the activities of the inhabitants in building houses, cultivating the hillsides, and herding grazing animals over the steep slopes. In many areas erosion is becoming a serious menace.

The studies here set forth were made in the confines of the Umzumbe River Valley in a section approximately 12 miles by road from the railway station named after the river. The Umzumbe River flows in a northwesterly direction. Twelve to 16 miles from the river mouth the valley lies behind high barriers of hills which cut off the tempering winds of the sea. Although rainfall is somewhat less abundant in these protected valleys, the xerophytic character of the vegetation is predominantly the result of insolation, the closed nature of these deep valleys, the consequent heating of the air, and the presence of strong reflections from neighboring surfaces.

The sections of the Umzumbe Valley allocated to natives (and they are badly over-crowded) are rapidly being denuded of all cover, either by direct human action or indirectly by the herds of cattle and the far more pernicious flocks of goats. As cattle suffer from depletion of their food supply, the natives keep an increasing proportion of goats, thus starting a vicious cycle which only can terminate in complete denudation of these areas. Other valleys and other native locations are faced with the same problems.

The native faunas of these districts suffer from the changes even before they become obvious to those interested only in the economic phases, and when these notes were being compiled, it was observed by native helpers that many animals which they had considered common a few years before, had practically disappeared.

During the 7 years that have elapsed between the collection of my specimens and notes, and the date of this writing (1935), floods and drought have played their part in affecting the terrain, and where dense bush once formed ample cover to shelter bush-buck and duiker, there remain now only small remnants through which a man can walk erect and see clearly for many yards in every

direction. Only on the private estates farther inland, on crown lands, and along the valley nearer the sea, are conditions at all comparable to those once found in the area under consideration.

The writer wishes to express his gratitude to Dr. Robert T. Hatt for his aid in the determination of some of the species mentioned in the following account.

ACCOUNT OF SPECIES

Crocidura cinnamonea.—i'nGosongoso. This name is applied to all of the shrews, although the smallest, a species of *Crocidura*, is sometimes referred to as simply i'nGoso. The natives have a peculiar legend relating to shrews, especially the smallest species. In effect, it is that no shrew is able to cross a path, and that the narrowest stretch of bare ground is an insurmountable obstacle to their movement. If the crossing be attempted the shrew dies. It is for this reason, they say, that shrews frequently are found lying dead in a path. Several of them may be encountered in the course of a mile, although dead mice almost never are met.

Crocidura sp.—i'nGoso, or i'nGosongoso. Although this species has not yet been identified, its very small size and constant association with termite nests mark it as an animal with rather conspicuous features.

Three specimens were collected, all in or near termite nests, and a fourth was seen running through the galleries of an abandoned termitaria. Two of the specimens (male and female) were secured almost simultaneously in a rather large, abandoned termitaria, in which there was a nest of exceedingly fine grass. The female contained 5 embryos, each about 4 mm. long.

Myosorex caffer.—i'nGosongoso. This dark, sooty-colored shrew is most abundant along the rivers, where it finds favorable conditions in the reed beds and dense grasses close to the water. It is one of the largest of the local shrews, reaching a length of 150 mm. An adult female, containing 3 embryos each 7 mm. in length, was collected July 13, 1926. Only one specimen was secured at any distance from the reedy margins of permanent bodies of water, and the single exception was obtained in thick bush in a very damp, almost marshy spot at the base of a cliff. All the specimens captured were characterized by a very strong, urine-like odor and the males possess an aroma somewhat musky in nature. The urine-like odor was localized in the region of the anus, while the musky smell apparently originated in a pair of glands near the axillae. These small glands are covered with a growth of short black hairs that are scarcely noticeable and easily escape attention unless looked for carefully. These shrews were rejected by domestic cats.

Chrysochloris hottentota.—Golden mole, or umVuguzane. Only one specimen of the red gold mole was collected, although what were supposedly their workings were encountered occasionally. The native boy who captured the one individual clubbed it as it was pushing up a mound of earth very early in the morning.

Rousettus collaris.—Fruit bat, or iGomonqo. Two specimens of this fruit bat were obtained in June, 1926, one on the 16th, the other on the 19th, the latter a male. It was noticed that in flight this species produced a distinct whistling sound, a characteristic not noticed in the case of the other 2 species. Both individuals possessed a faint but unquestionable fragrance suggestive of that noticed on the birds which had been feeding on nectar. There was no sign of pollen to indicate that they had been frequenting flowers, but the fragrance was definitely not a fruity odor. Both individuals were caught by placing a rat-trap, baited with bananas, in a loquat tree where fruit bats regularly were feeding

Epomophorus crypturus.—Lesser epauletted fruit bat, or iGomonqo. This is the most common fruit bat in the Umzumbe Valley and specimens easily were obtained either by

shooting or trapping. At times they were present to the number of 15 or 20, fluttering around either loquat or wild fig trees. In feeding they prefer to flutter near the fruit clusters until they have torn off a berry, when they retire to some sheltered spot to devour the food before returning for more. At times they hang head downward from a limb of the tree where they are feeding, and upon these occasions their eyes shine a light red when in the rays of a flash light. Shooting is the most satisfactory method of collecting them. They have a more regular flight than the smaller insectivorous bats. They may be trapped also, for they will come to bait quite readily and if unable to feed while flying, will alight just below the fruit. They seem to prefer snatching food on the wing. It was found that a trap placed in a loquat tree where the fruit was ripening was made more effective by using bananas as bait.

Although no definite information concerning the breeding season was obtained, an immature specimen was collected January 16, 1926, and an adult female with enlarged mammae was taken February 25, 1926. Another adult female collected June 17, 1926, showed what appeared to be a post-nursing condition; the mammae were large, pendulous flaps but contained no milk.

Epomophorus wahlbergii.—Epauletted fruit bat, or iGomonqo. These are the largest of the local fruit bats. They seem to be quite rare and only two specimens were collected. It is known that at least one of the fruit bats has a rather loud call-note and at times the bats may be heard calling for hours from some roosting place in the bush. It was not possible to determine which species produced the call, a honking whistle, or whether all were capable of producing it.

Nycteris capensis.—Cape slit-faced bat, or isiTutanhlebe or isiLulwane. Only two individuals were collected, March 2, 1926, both from under a house and only a foot or two from the ground. Two other individuals were seen, singly, in the same situation.

Rhinolophus capensis.—Cape horseshoe bat, or isiTutanhlebe or isiLulwane. One individual, an adult male, was taken March 6, 1926. Testes and penis were very large, possibly indicating breeding condition.

Hipposideros caffer.—African leaf-nosed bat, or isiTutanhlebe or isiLulwane. This is the most common species of bat in the Umzumbe Valley and undoubtedly is the one to which the native names are most frequently applied. The natives seem to make no distinction between the various species of bats except between the fruit bats, Megachiroptera, and the Microchiroptera. Thirteen specimens of this species were obtained. On March 2, there was collected a female having one mamma containing milk, the other dry. On March 7, one individual was secured, and it was noticed that the skin was exceedingly tender, far more so than in the other specimens. The bones of the digits had hardened, however, and it may therefore have been an adult. Other specimens were taken in February, June, and in October.

All the bats of this species were collected in deserted rooms and closets, and were found clinging to brick walls, 6 to 8 feet from the ground. When disturbed or excited they exhibited a peculiar habit of jerking the head about with sharp and regular motions.

Vespertilio minutus.—Small serotine bat, or isiLulwane or isTutanhlebe. This little bat most frequently is obtained at night, in the house, where it wanders into the lighted rooms and flies back and forth across the ceiling, or in and out of the doorway.

Pachyotis nigrita dingani.—Yellow bat, or isiTutanhlebe or isiLulwane. These rather large and attractive bats were difficult to collect, since they are exceedingly active and leave the vicinity of their roosts with no loitering about. Apparently they fly relatively high, for they never were collected near the ground except when a lucky snapshot brought them to earth just as they were leaving the roosts. They appear to find satisfactory shelter under the folds of the corrugated iron roofs where a space is formed between a roof-beam and the corrugations. It is difficult to understand how any animal survives the terrific heat of such a place.

Stomach contents consisted of the usual mass of finely ground insect material. An individual collected March 2, 1926, was found dying, possibly from snake bite, on the floor of an outbuilding. Drying blood matted the hair in several places on breast and neck, and had seeped from punctures in the skin. The animal was exceedingly fat, the adipose tissue along the back reaching a thickness of 2.5 mm. in some places. The testes and penis were very large, the former being 13 mm. long, while the entire animal was only 129 mm. in length. In the 3 specimens collected, the ventral coloration ranged from bright to dirty sulphur-yellow, and the dorsal surface in each case approximated a brownish olive-green. Unlike most bats, this species does not possess the musty, disagreeable odor so characteristic of the Microchiroptera, although a strong oily smell is very noticeable.

Miniopterus natalensis.—Natal sociable bat, or isiTutanhlebe or isiLulwane. Two specimens were collected, March 23 and May 9. Both had entered a lighted room. The power of flight was noticeably inferior to that of other species. The bats flew close to the floor, alighting low on walls or drapery. One of the individuals voluntarily settled on the floor.

Nyctinomus aegypticus.—Brown wrinkled-lipped bat, or isiTutanhlebe or isiLulwane. Three individuals were collected, one each, in October, February, and March. One specimen smelled strongly of rotten fruit, the other, which had flown into a room at night, soon made the air almost intolerable with a rather acrid odor quite different from the usual musty smell of bats.

Lutra capensis.—Cape otter, or umTini. Although there were collected no specimens by which the local species could be identified, the descriptions of the skins and of their approximate size given by natives and white residents indicate that this is probably the resident species.

The otter is not rare but all attempts to capture a specimen resulted in failure. The natives asserted that it is absolutely essential to set otter traps in 6 to 9 inches of water. Traps were placed in this manner several times, but on each occasion the animals moved from the vicinity immediately thereafter. From time to time otter dens were found along the banks of the river. In all cases there were tunnels through very dense tangles of underbrush leading to small clearings where grass and vegetation had been rolled flat and killed by repeated trampling. The ground usually was found packed hard and smooth, and the dens could be smelled for a distance of 15 or 20 yards. Quantities of fecal matter, composed almost entirely of the remains of crustacea, had been deposited close to the runways. Occasional evidence of fish was found, but apparently the principal food consists of fresh-water crabs. No evidence was found to indicate that the otter attacks animals other than cold-blooded forms, but the Zulus blame many chicken-yard depredations on this animal, and it is entirely possible that it may resort to the vicinity of dwellings in order to rob the roosts. It is known to turn on dogs that are pursuing too closely and it is capable of killing even the largest of them, according to natives who have been eye-witnesses of the one-sided battle. The Zulus value the oil as a cure-all of various pains.

Poecilogale albinucha.—Snake weasel, or inYengelezi. The little snake weasel is one of the rarest carnivores in the valley. Very few ever are captured and the natives either refuse to bring them in, or demand exorbitant prices for the skins. All parts of the body are used in the native pharmacopoeia, and the elders wear a narrow strip of the fur just below the head-ring to ward off evil and to bring good luck. It was not learned just why the animal is considered so valuable, and all the natives seemed much more reticent concerning its virtues than about some of their other medicines. Nothing could be learned of the habits of the species except that it apparently frequents the burrows of subterranean animals in gardens, is sometimes plowed up, and will attack and kill snakes. A rather reliable Zulu described a battle between one of them and an

iMamba 6 or 7 feet long. He stated that he had been sitting near the bush watching the snake (the native, umDitshwa, was an inyanga or doctor, which may explain his willingness to remain near the reptile) and that it coiled to bask in the sun in a little clearing. After a few minutes a movement in the bushes caught his attention and he saw this inYengelezi cautiously stealing toward the snake. When within a foot or two, the animal suddenly leaped upon the reptile and fastened its teeth just behind the head, where it clung during the ensuing wild struggle. After a few minutes it succeeded in killing the snake, then relinquished its hold, performed its toilet, and left without eating any part of its prey. In the light of the latter statement, it is difficult to understand the attack.

Genetta tigrina.—Genet, or inTsimba. Genets were not rare and could be caught at almost any time without a great deal of effort. A carefully concealed trap with a decaying rodent swinging above the pan was found to be the most effective method of capturing them. The stomachs contained either rodent fur and remains, or a mixture of rodent and vegetable matter. One stomach held only grass and soft leaves. Undoubtedly birds, rodents and other small animals form a part of the diet but the series of specimens was insufficient to give a satisfactory picture of the food habits. When approached at the trap there was little show of resistance, but mainly an attempt to back away to shelter. One adult male, however, fought fiercely, hissing like a cat and attempting to charge, but for the most part there was no show of savagery except when touched. The usual behavior substantiates to some extent the statement of the natives that when caught young the inTsimba makes a delightful and docile pet. When angry or frightened, the tail is bushed out like a cat's and sometimes, if a male, a fur-lined pouch or pocket near the scrotum is everted and an oily fluid squirted for a distance of a foot or two. There are two types of fluids, one having a rather pleasant but excessively heavy musky odor, the other a very disagreeable smell suggestive of bone-meal fertilizer. The two substances are derived from separate glands, the musk coming from the fur-lined pouch, the other from anterior to the testes.

The natives are fond of the flesh of the genet and use the skins for various decorative purposes. The tails particularly are prized for use in the anterior portion of the mutsha or skin apron. The flesh may be palatable to a Zulu but it is too odorous to appeal to a white man.

Mungos caffer.—Ichneumon, or umHlangala. This is the largest of the local species of the Viverridae, and although it is not common the natives maintain that it does a great deal of damage to game birds, destroys many chickens and other domestic fowls, and at times even kills young iPwiti antelope (*Cephalophus monticola*). No evidence was obtained regarding general feeding habits but this undoubtedly was one of the animals that periodically raid the fowl roosts. Ground dwelling birds also must suffer from its attacks. It is large and powerful and often puts up a good battle against the native dogs, sometimes damaging its opponent considerably. A large mongrel, part fox terrier, with the temerity to attack one, succeeded in killing it but was itself so badly injured as barely to survive, and recovered only after 2 or 3 weeks of care. The animal runs comparatively slowly, and its short legs and heavy body suggest a woodchuck. The natives believe that it is capable of running steadily all day, and they say that when it is pursued by dogs and temporarily becomes wearied, it will suza (leave a strong odor in the air), "and the dogs coming to the spot yell, hy, hy, hy hy hy, here he is, here he is, here he is, hereabouts close at hand. When they don't find him they say he can't be far, and work about to locate him. By the time they learn that they have been fooled and start following the spoor, the hlangala is a long way away and is safe."

Herpestes gracilis typicus.—Slender mongoose, or uBozo. The slender mongoose is comparatively rare, judging by the results of trapping. Two were collected, September 23, an adult male, and a female containing two embryos 12 mm. in length, one on each

side. Rats were used as bait. The stomach contents of the female consisted entirely of rodent remains. The contents of the male consisted of 80 per cent rodent and 20 per cent insect remains, the latter composed largely of Coleoptera elytra. Both specimens were taken in the bush. These animals are reputed to kill snakes, but no native was found who had seen them actually make a kill or who had found positive evidence.

Felis caffra.—Kaffir cat, or imBohla. Only one specimen is recorded from Umzumbe, taken by F. B. Cowles in 1920. The cat was treed by a dog and was shot while hiding among the branches and vines about 20 feet from the ground. The natives are familiar with the species, and one boy who, on almost every possible occasion, mimicked to perfection every imaginable sound, gave what he claimed was an imitation of its growling which he had heard in the bush at night. The noise resembles the growling of a domestic cat but is somewhat huskier and deeper.

Felis pardus.—Leopard, or iNgwe. None was seen during 1925 nor subsequently, but during 1924 one was killed in the coastal bush a few miles from the mouth of the Umzumbe River. It is not impossible that this is the last which will ever be seen in the region. Since there are places within 100 miles of the Umzumbe, where leopards still are abundant, there may be other strays appearing from time to time, but the likelihood of their negotiating the intervening settled regions diminishes with every passing year.

The other larger carnivorous animals have not been reported from the valley for a great many years, although there still are occasional rumors of hyaenas having been heard; but it is exceedingly doubtful if any have occurred for the last 30 years. Very few natives still living ever have heard a lion (nGonyama or iBubesi) in Umzumbe, although a few still speak of them and refer to the nGulule or hunting leopard (*Cynaelurus jubatus*) and the imPisi or spotted hyaena.

Rattus rattus alexandrinus.—Roof rat, or imPuku, inJova. Most of the larger rats are known by the former native name, which usually is applied to members of the genus *Rattus*. By common usage one assumes that the Zulus ordinarily do not differentiate between species within a genus. Only one native explicitly stated that the roof rat was distinguished by the name inJova. Wherever roof rats were present the trap line suffered from their depredations. In one section, where trapping was carried on within 100 yards of a deserted house, almost every animal caught was partially or wholly destroyed. Until larger traps, baited with the remains of these victims, were used, it was not known what animal was doing the damage, but after 5 roof rats had been captured, the depredations suddenly ceased.

Rattus chrysophilus tsaneenesis.—African rat, or imPuku. This is the most attractive species of rat found in the region. The fur is soft and beautifully colored, the predominating shade being a rich brown. Unlike most of the rodents this species possesses no disagreeable odor; in fact while skinning them, it was thought that the odor of the flesh most closely approximated that of some of the upland game birds. Most of the individuals collected were preserved, but on the very few occasions when they were used as bait they were found to be most satisfactory. Traps so baited were unfailingly successful, at times catching even birds. No individuals were collected except in the bush, and judging by trapping results they do not wander far from their chosen haunts. Even traps set in heavy brush near the edge of the bush failed to yield a single specimen.

A female taken July 10, 1926, contained 3 large embryos.

?Mastomys coucha natalensis.—Multimammate rat, or iGundane. The identity of this rat is not certain. It is by far the most common and most widely spread rodent in the Umzumbe Valley. The animals were found in virtually all habitats except very wet, muddy marshes, but even there one was obtained. It is in the open fields, however, that one finds them most commonly, and here they constituted about 80 per cent of the catch, the other 20 per cent comprising shrews and rodents of other sorts.

This rat undoubtedly forms a large proportion of the food of various carnivorous animals, and their remains comprise the major bulk of owl pellets. Trapped specimens usually are partially or wholly destroyed by other rats or shrews. The most useful bait for general purposes, and the one which attracted the greatest number of species, was a mixture of bacon fat, peanut-butter, and cornmeal. Raisins, dried fruit, bacon alone, and grain, proved to be unsatisfactory. The flesh or brains of the iGundane appeared to be almost as acceptable as the combination mentioned above and was even more effective for attracting shrews.

Leggada minutoides.—Dwarf mouse. Only 3 specimens of this species were observed. In each case they were found either near or in rather dense brush. One was collected June 12, the other two on June 21.

Rhabdomys pumilio chakae.—Striped mouse, or umQana, or sometimes uNombiba. The striped mouse was difficult to obtain. Their workings, consisting of short lengths of certain species of grass and herbs, were not difficult to find, and although special effort was made to obtain specimens, only 3 were caught. All lures were tried but only the mixed bait proved successful.

Dasymys incomptus.—Peters water rat, or iBuzi. These water rats apparently were common, judging by their sign, in the form of short cuttings of coarse grass stems, and droppings. They were mentioned frequently by the Zulus, who sometimes distinguished 2 forms, the black ones living in the fields and the present species. The former was not obtained and it is unknown whether there actually is a second species. One native, however, referred to this form as iBuzi ya ma hlanga (the reed-bed iBusi), and maintained that it was not the common species. The small native boys sometimes spear and eat the amaBuzi.

Georychus hottentotus.—Mole rat, or imPaka or imPukuluti. Only one individual was obtained and this was brought to me by natives who had plowed it up in a garden. It was said that it is greatly feared as a messenger of witches, and that its presence near a house invariably signifies serious trouble. When seen near a house, inTelezi (charm medicines) are sprinkled about to ward off the danger. Nothing is known of its habits.

Thryonomys swinderianus.—Cane rat, or iVondwe or iDwele. Cane rats still are present in small numbers but are no longer common except in a few limited areas, or nearer the river mouth on the estates of the Europeans. The areas where there is sufficient cover for these secretive animals steadily are growing fewer and smaller, and with increased exposure through reduction in the size of the cover, native hunts are successful in destroying almost all individuals. On large estates, where the concentration of natives and cattle is less and on the sugar cane plantations, the cane rat still thrives.

It is difficult to obtain perfect specimens of the cane rat from the Zulus. No vestige of a tail remains soon after the rat has been killed, for to eat an animal with a naked tail appears to be disgraceful and the appendage quickly is removed. My informant stated that immediately after an animal has been killed there usually is called a witness to attest to the fact that the tail is lacking.

These large rats occur wherever there is an abundance of tall grass or reeds, and since these conditions are found in the damper sections, the population usually is concentrated in valley bottoms. Occasionally, however, sign was encountered higher on the hills, where tall grass and thickets of weeds and shrubbery afforded sufficient shelter and food. Whether or not this is a recent development because of pressure caused by contracting habitat, or whether it was one type of habitat previously used by a smaller proportion of the race, is unknown.

?Pronolagus ruddi.—Red hare, or isiBudu, sometimes unoGwatsha. A hare, probably the red hare, is present in this territory, but none was collected and the identity of the species is uncertain. A few were seen, but they were rare in the valley, whereas they were common above the cliffs at an altitude of 2000 feet and more.

Procavia capensis natalensis.—Natal dassie, or imBila. According to the natives dassies at one time were fairly common on many of the cliffs along the edge of the valley, but for the past few years they have gradually diminished in numbers. Since the natives consider them to be good food and hunt them frequently, it is not surprising that they now are scarce. Only 2 colonies were found, but doubtless others exist in more remote and inaccessible sections of the higher cliffs. There were not more than a total of a dozen individuals. It was noticeable in each of the groups that some individuals were dark and others light in coloration. Whether or not this is sexual dimorphism or whether the coloration represents two phases irrespective of sex, was not determined. Only a male and a female were taken. The former was a light grizzled brown, the female grizzled black. Two embryos (June 24, 1926) measured 38 and 40 mm., right and left horns respectively. The favored type of habitat is along the higher, inaccessible cliffs, where narrow ledges support a sufficient food supply, and furnish safe retreats to which most of the larger carnivores and man cannot climb. In appearance and action the dassies bear a superficial resemblance to woodchucks, and like them are difficult to obtain by shooting, for if not killed instantly they fall into the crevices of the rock where they have their dens. It is interesting to note that 2 white men living in the valley refused to eat the dassie, claiming that it harbored syphilis. And yet the Zulus have eaten them since days long before the disease was introduced by Europeans. It is difficult to understand how such a suspicion could have arisen, the only possible explanation being that the dassie may be afflicted with some disease which produces ulcers. According to the natives the chief enemy of the dassie is the rock python, which sometimes is called iDhla mBila (eat the dassie). Another name is uMonya.

No other species of hyrax was found in this region, but some of the older Zulus claimed that at one time a tree-dwelling species with a white mark (ibala) on its back lived in the bush along the lower edges of the cliffs. The fur was said to be softer and much more beautiful than that of the present species. It also was said that a few might still be found in the valley of the Umzumkulu River. An attempt was made to obtain a skin of the tree hyrax from the natives but none was forthcoming.

Tragelaphus sylvaticus.—Bush buck, or inKonka (male), imBabala (female). A very few bush buck still remain in the valley, although on European property, somewhat more remote from the borders of the native location, they still are fairly abundant. They are found only in the thick bush, or reed-beds near such bush, although at night they wander along the edges and even pass to small patches of scattered bush where they occasionally spend the night. On the native locations they rapidly are dwindling in numbers, especially since wire snares have come into vogue. A few natives spread these wire loops on game trails throughout the bush and then systematically beat the cover. The animals dash along the trails and ensnare themselves in the loops, which soon strangle them. The entire proceeding can be carried out rather quietly and is a most effective way of poaching. Since snares catch young and old, and both sexes indiscriminately, it is obvious that the extensive use to which they are being put eventually will result in complete extermination of certain species of game. It will be a tragedy when the camper no longer will be able to listen to the dog-like barking of the bush buck at dusk or during the night.

Cephalophus grimmi.—Duiker, or imPunzi. The common duiker at one time was exceedingly abundant in the section of the Umzumbe Valley visited. Until 1923 it often was found and was considered the second commonest antelope. From 1925 to 1927 only one was seen on the native location; from 1928 to 1929 none was noted. During the former period tracks were observed from time to time, especially about the fields of beans and sweet potatoes near the few remaining cover areas. Even during the native hunting drives, however, when 20 or 30 natives and twice as many dogs beat through

bush and grass, not one was put up. It is probable that a lone survivor was responsible for the tracks. On the European estates and farms a few miles away the duiker undoubtedly will remain fairly abundant. So far the natives have developed no successful method for poaching duiker, and the open country which they inhabit does not favor illegal hunting.

Cephalophus monticola.—Blue bush duiker, or iPwiti. This is the smallest of the South African antelopes and probably will be the last to disappear on native locations; but there is no reason why it ever should become extinct on private land. It is found only in dense bush, usually where there is an abundance of the plant maBomane (*Isoglossa woodii*). Its small size and protective coloration render it exceedingly difficult to see, and even when seen the nature of its habitat renders it difficult to kill. Small size is a particularly advantageous feature, for unlike the larger animals, a small creature can manage with only constricted sections of its habitat remaining. Even on the native locations the amaPwiti still are fairly common, although they are becoming scarce quite rapidly. Snares again are responsible for this diminution. So far as was observed the iPwiti makes no perceptible vocal sounds unless badly frightened or injured, when it gives utterance to a loud shriek resembling that of a hare when caught by dogs. Both this and the preceding species possess facial glands that excrete a crystalline substance having a rather strong odor and an exceedingly bitter taste.

An interesting trait, which was observed and is frequently reported, is the association between this antelope and monkeys. Whether this is for protection or whether the monkeys in their forays for fruit drop food which the antelope then recovers is unknown. It frequently was noticed that when monkeys appeared in the bush, either driven in a hunt or when merely wandering about, the iPwiti also was present. The topic needs further study and might prove interesting.

Galago crassicaudatus garnettii.—Bush baby, or iSinkwe. The bush-baby is mentioned here because the natives know it by name, although they reported that it is not present. None ever was heard, and on making enquiries it was stated that the animal is not found south of the Umkomazi River.

Cercopithecus pygerythrus.—Vervet monkey, or inKawu. Monkeys are the only large and conspicuous animals that do not seem to be in danger of extermination or serious diminution in numbers. The natives hunt them persistently, and trap them in the fields when possible, but never are very successful. The local natives eat the flesh, which has a taste very much like that of corned beef and is somewhat similar in color. The meat is boiled and then allowed to cool before eating, and monkeys therefore have been dubbed Umpeka'pole (cook and cool). They also sometimes are called "Abantu aba n'tshontshayo" (the people who steal), probably their most apt cognomen. It is difficult to conceive of more mischievous and thieving animals than the monkeys, and they, with the native herder boys, proved a perpetual source of annoyance. No bird nest marked by the presence of a "blind" was safe from molestation and probably only one out of 50 nests so marked would be left unharmed. Garden patches so persistently are raided by monkeys that in some places it is almost impossible to harvest even a moderate proportion of the crop, and natives from distances of several miles sent requests for help against the raiders.

Probably no animal in the Umzumbe Valley is more interesting to watch and study than this primate, and notes on its behavior accumulated rapidly. These, however, are not sufficiently complete to warrant publication in full, and do not belong in the present account.

The natives reported the presence of another species of monkey from the deep bush on Crown lands farther up the valley, but no pelt was observed and no specimen collected. The name unTsimangwe suggests that the species may be *Cercopithecus samango*.

Papio porcarius.—Chacma baboon, or imFene. The chacma baboon is almost, if not quite, extinct in the region studied, although persistent reports of its presence along the cliffs 3 or 4 miles away may indicate that there are a few survivors. None was seen, however, and since the natives have many superstitions concerning this animal, it is not safe to assume that their statement of existence in a region means even as much as a possibility. The natives believe that witches send the baboon on errands, or at times that they even carry the witches, so that it is no unusual thing to learn that the baboons travel widely at night and have appeared where they would never wander even in the daytime, miles from any possible habitat.

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HIBERNATION OF THE BROWN BAT

By Alexander Wetmore

One evening during the first week in December, 1934, as I let down an awning over one of my office windows, a brown bat (*Eptesicus fuscus fuscus*) fell from the folds of canvas to the stone window sill, where it sprawled helplessly, partially benumbed by cold. As I watched, it occurred to me that it would be interesting to know if a bat successfully could pass the winter in such an exposed situation. With this in mind I confined the bat in a pasteboard box on the window ledge, keeping it in this situation until the next day. The weather was sharp but not particularly cold.

A small, ventilated box was constructed and a double layer of soft woolen blanket was tacked along one side. The bat was placed head down within these folds. A thermometer with a long scale was inserted through a tight fitting hole in the top of the box, and was supported by a special plug so that the mercury in the base rested beside the section of the blanket containing the bat. The amount of air in the box was reduced to about one half by filling the lower part with cotton and some scraps of blanket. The entire arrangement was intended to simulate the conditions that a bat might encounter in a tree hollow partly filled with rubbish and with a small external opening.

The box was fastened on the sill outside the window where the bat had been discovered, with the animal toward the outside, and the thermometer in such position that it could be read from within the room. The window faced due west on the third floor of the Natural History Building of the U. S. National Museum, at an elevation of about 70 feet above the ground. While the box was not shaded from the afternoon sun it was open to the sweep of cold west and northwest winds to such an extent that it was necessary to tie it in place to prevent it from being blown away.

Temperatures recorded by the thermometer were read between 8:00 A.M. and 8:30 A.M. daily except Sunday. These began on December 8, 1934 and continued until March 20, 1935, during which time neither box nor bat were disturbed. The monthly variation in morning temperature was as follows:

December	+ 9.6° to − 4.6°Cent.
January	+11.7° to −14.0° "
February	+13.7° to − 7.6° "
March	+15.6° to + 2.3° "

The temperature of the inside of the box near the bat was for all practical purposes the same as that of the external air, as was determined by means of a second thermometer fastened to the window frame. The only difference apparent was that fluctuation in temperature proceeded less rapidly within the box than it did outside. No attempt was made to record the highest temperatures of the day, which came in the afternoon, due to the sun, since the point in the present experiment was to determine minimum temperatures that the animal could sustain. Under these conditions the bat lived successfully through the winter.

On the evening of March 11, a brown bat was seen flying at dusk near Lucketts, Virginia, on the Potomac River 35 miles northwest of Washington. The weather continued warm on March 12 but then was colder until March 16. On the afternoon of the last date mentioned the air was balmy and the afternoon sun shone warmly against the west windows. At 3:30 P.M. I moved the box carefully inside to a study table and found the bat breathing normally and chattering its displeasure at the disturbance. The inside temperature of the box was +30.0° Centigrade.

Upon opening the lid I found that the bat had crawled outside the blanket fold where I had left it in December, and was resting on the outside of the cloth with its head thrust behind the thermometer. As I touched the bat it turned and threatened me with open mouth. Without disturbing it further I replaced the cover and set the box outside. Here it remained until March 20, when at 8:30 A.M. with the thermometer registering +3.8° Cent. I found the bat resting in a semi-torpid condition beneath a bit of blanket in the bottom of the box. It had in the interim moved about beneath the outside opening as was indicated by droppings at that point.

The day promised to be warm and pleasant and I removed the screen covering the opening. At 5:20 P.M. the bat had gone. I left the box in place for a few days, examining it each morning to ascertain if the bat had returned, but saw nothing more of it. The data given are some indication of what a hibernating bat may encounter while wintering in this latitude.

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DEVELOPMENT AND GROWTH OF PEROMYSCUS MANICULATUS OREAS

By Arthur Svihla

The present report is a result of a study of the development and growth of *Peromyscus maniculatus oreas* Bangs, the third race of this species investigated in this connection. Data on the growth of the subspecies *artemisiae* and *bairdii* already have been presented (Svihla, 1934, 1935).

The deer-mice belonging to the subspecies *oreas* are distinguishable from other races of *maniculatus* by their dark, rich coloration and the great length of the tail. The latter, according to Osgood (1909), is longer than in any other subspecies of this species. These mice inhabit the moist mountain and coastal regions of western Washington, and southern British Columbia around Puget Sound. Osgood (1909) stated that they intergrade with *artemisiae* in central British Columbia, but in the region around Mount Baker, where was secured the original stock for this study, no intergradation occurs. The mice were collected alive in "Burt" traps set near the Nooksack Power Plant some 10 miles east of the town of Glacier in the Mount Baker National Forest. The forest here is typical of the western coastal region, consisting of such valuable trees as western red cedar, Douglas fir, western hemlock, and silver fir. The undergrowth consists chiefly of tangles of salmonberry, salal and huckleberry.

The methods used in breeding these mice and the conditions under which they were raised, were the same as those in the studies previously reported. They were fed the same diet, consisting of ground whole wheat, powdered milk and iodized salt, with the addition of green food twice a week. About 5 grams of raw beef liver also was given each mouse once a week. In a previous paper (Svihla, 1933), I stated that when these mice were brought from the coastal region to Pullman, they failed to reproduce, although they bred normally while in western Washington. The present stock of *oreas* likewise failed to breed when transferred to Pullman until liver (5 grams once a week) was added to the diet, since which time they have reproduced normally. This confirms the observations of Smith and Seegers (1934), who reported similar beneficial effects from the addition of raw liver to the diet of experimental rats and mice.

Newly born young of *oreas* did not differ in general appearance from those of other subspecies of deer-mice of the *maniculatus* group. They likewise were pink in color, hairless, with eyes closed and the pinnae of the ears folded down over the aural opening. The vibrissae were well developed. Within 24 hours the backs of the young mice became deeply pigmented from the presence of coloring matter in the developing hairs. On the fourth day the pinnae of the ears were erect, although the ear openings still were closed. The time required for the eyes to open varied from 14 to 18 days but usually took

place on the sixteenth day. The gestation period of non-lactating females was 23 days, whereas this period usually was prolonged to about 25 days when the female was nursing young. As soon as the second litter appeared the young in the first litter were forced to shift for themselves. This they were quite able to do since the weaning process began when their eyes first opened.

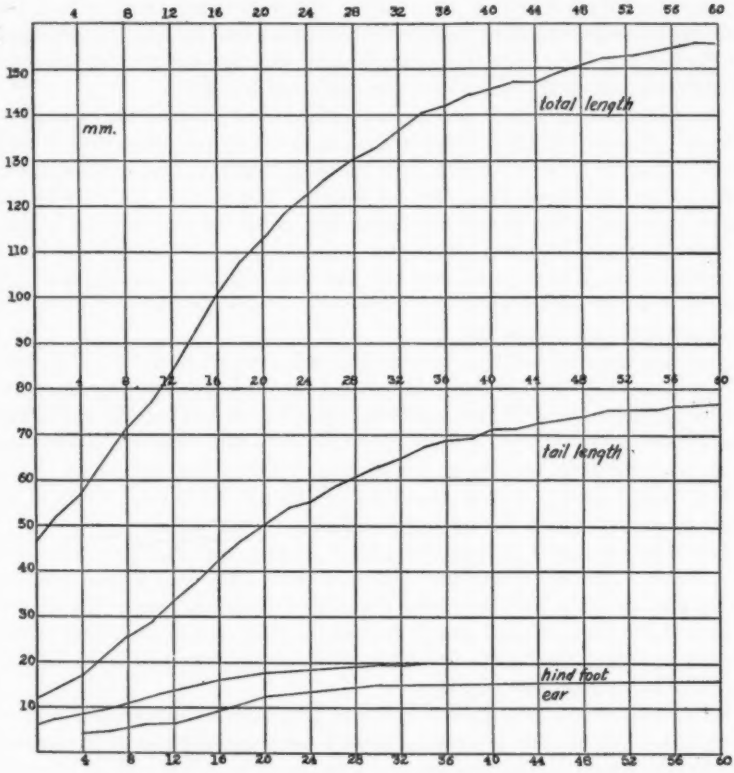

FIG. 1. MEAN GROWTH CURVES FOR *Peromyscus maniculatus oreas*

The usual measurements of total length, tail length, hind foot and ear, were made, and the weight taken by the author every two days from the birth of the mice until 60 days thereafter. The mean and the probable errors for each measurement were calculated and the results arranged statistically. Thirty-three litters totalling 110 mice were weighed and measured. The smallest number used at any one age was 25. Although this is a small

number, nevertheless it is considered sufficiently large for statistical tabulation and comparison.

At birth the total length varied from 39 to 52 mm., with a mean of 46.09 ± .21 mm. The mice grew very rapidly until about the twenty-fourth day, at which time the mean length had increased about 2.6 times. After the twenty-fourth day the rate decreased, for at the end of the period (60 days) the mean length was only 3.4 times that at birth. Approximately two-thirds of the measured increase in length took place in less than half the measuring period. At the sixtieth day of age the mice still were growing slightly, for the total lengths lacked only 18 mm. of the mean adult length (fig. 1).

The tails varied from 9 to 15 mm. in length at birth with a mean of 12.27 ± .06 mm. The rate of the increase in tail length closely paralleled that of total length. This perhaps is obvious, since the total length of an animal is dependent to a certain degree upon the tail length. The greatest increase in tail length occurred before the twenty-fourth day, when the tails were more than 4 times the length at birth. After the twenty-fourth day the tails continued to grow, but at a slower rate, for at 60 days the tails were but slightly more than 6 times the length at birth. At 60 days of age the tails lacked but 15 mm. of being adult in size (fig. 1).

The variations in lengths of the hind foot at birth were from 5.6 to 7.1 mm., with a mean of 6.50 ± .21 mm. Growth of the hind foot was very rapid for the first 24 days, for at this time the length had almost trebled and lacked but about 2 mm. of adult size. After the first 24 days there still was a slight increase in length, but from then until the sixtieth day only about one mm. was added. At 60 days of age the mean hind foot length lacked about one mm. of being mean adult size for this subspecies (fig. 1).

The mean ear length at birth was 4.25 ± .37 mm. with variations from 3.1 to 5.5 mm. The ears lacked but 3 mm. of being adult size by the twenty-fourth day, or at the time the young were able to leave the nest. The rate of growth of the ear paralleled closely that of the hind foot in that most of the growth took place during the first 24 days, at which time the ear lacked but 1 mm. of being adult size (fig. 1).

The new-born young weighed from 1.1 to 2.3 grams, with a mean of 1.63 ± .12 grams. The increase in weight showed a very constant rate of increment, for the mice gained approximately .5 grams per day. By the twenty-fourth day they had increased in weight about 5 times. At 60 days the mice lacked but 3 grams of having the mean adult weight (fig. 2).

The rapid rate of growth prior to the twenty-fourth day may be credited to the fact that food and environmental conditions were more uniform and perhaps more favorable for growth during this time than afterward. On about the twenty-fourth day a new litter usually was born, and the mice in the first litter were forcibly weaned and made to shift for themselves. Although the weaning process usually commenced when the eyes opened,

about the fifteenth day, the young mice still were dependent upon the mother for some nourishment. Until their eyes opened they were relatively inactive, so that most of the food intake was utilized for new growth. As their activities increased a larger proportion of the food was needed for energy and repair.

Comparing the mean body measurements and weights of the subspecies *oreas* with those of *artemisiae* and *bairdii*, some interesting relationships are

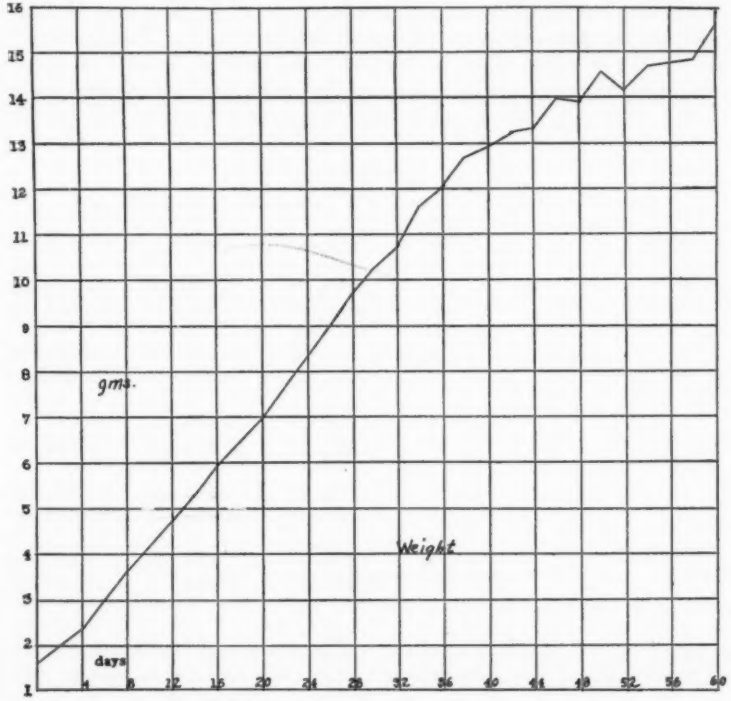

FIG. 2. MEAN WEIGHT CURVE FOR *Peromyscus maniculatus oreas*

brought to light. The subspecies *artemisiae* and *bairdii* already have been compared (Svihla, 1935). Briefly it was shown that the chief differences (aside from coloration) between these two subspecies were in the total length and length of tail, which were found to be statistically different, even at birth, in these two subspecies. The mean total length at birth of *Peromyscus maniculatus oreas* does not differ from that of *artemisiae* (46.09 ± .21 as compared to 45.57 ± .32). At 60 days of age, however, there is a statistical difference between them (158.68 ± .77 and 152.96 ± .71 respectively). As it

is similar to *artemisiae*, *oreas* shows a greater mean total length than *bairdii* throughout the first 58 days. It is in the mean length of tail that the subspecies differ among themselves, at birth as well as at 58 days of age, *oreas* having the longest tail (12.27 ± .06 at birth, 77.07 ± .54 at 58 days), *artemisiae* next (11.30 ± .08 and 70.83 ± .62) and *bairdii* the shortest (10.49 ± .06 and 51.00 ± 1.15) (Table 1).

No significant differences in the length of the hind foot or weights of these 3 subspecies were noted during the measuring interval. The sizes of the ears at the time the pinnae first unfold also are not significant. There is no difference in the ear length of *P. m. artemisiae* and *oreas* at 58 days of age, but *bairdii* differs significantly in having a shorter adult ear than either *artemisiae* or *oreas*. This may indicate that *artemisiae* and *oreas* are related more closely

TABLE 1

Comparison of the three subspecies of Peromyscus at comparable ages

	DAYS	OREAS	ARTEMISIAE	BAIRDII
Total length	0	46.09± .21	45.57± .32	43.62± .26
	58	158.68± .77	152.96± .71	130.00± .84
Tail length	0	12.27± .06	11.30± .08	10.49± .06
	58	77.07± .54	70.83± .62	51.00±1.15
Hind foot	0	6.50± .21	6.44± .35	6.15± .28
	58	19.87± .59	19.42± .76	17.60± .96
Ear	4	4.25± .37	4.49± .48	3.42± .50
	58	16.39± .87	16.39±1.10	13.43± .74
Weight	0	1.63± .12	1.81± .08	1.62± .13
	58	15.52± .92	17.83±3.11	15.45±1.67

to each other than *bairdii* is to either. This is attested further by their relative distributions. The subspecies *artemisiae* and *oreas* occur side by side in the northwestern states, whereas *bairdii* ranges through the mid-west and is separated from the others by the subspecies *osgoodi*, which occurs in the intervening Rocky Mountain region.

In conclusion it may be said that, aside from coloration and distribution, the most obvious difference between these 3 subspecies is in the length of the tail and upon this character a statistical series of these mice can be separated from each other even at birth.

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RECENT DEVELOPMENTS IN THE PRESERVATION OF THE WISENT IN GERMANY

BY THEODORE G. AHRENS

In the spring of 1936, there is to be opened a new wisent park near Munich, in connection with the Hellabrunn Zoo. The means for this undertaking generously were contributed by the New York Zoological Society to the International Society for the Preservation of the Wisent, for the purpose of preserving and increasing the number of wisents as far as is possible. In Das Tier und wir (October, 1935) Heinz Heck, director of the Hellabrunn Zoo, has stated what generally is known regarding previous efforts to preserve the wisent in Germany, and has offered recommendations for further action toward this end.

If one considers only the number of wisents now existing, the efforts of the past 15 years might appear discouraging, for whereas there were reported 60 wisents at the time of their first census after the war, today there are still only 75 living animals. There are many causes for this situation, an important one being the fact that forest culture as now practiced in Germany affords too little underbrush for browsing and too few kinds of trees for the requirements of the animal.

Heck claims that wisent and bison merely are geographic variants of the same animal, just as are the American and European moose, and the respective forms of the beaver. In this opinion he disagrees with many zoologists, and most books on natural history consider the two to be different animals. This point of view must be kept in mind when considering the much criticized *Verdrängungs-* or *Rückkreuzungszucht*, embodying the idea of breeding purebred wisent bulls to bison cows. This proposal was made at the time of the founding of the International Society, in 1920. The first offspring of this cross is a halfbreed. When a cow of this genetic composition is mated to a wisent bull the product is three-quarters wisent, and so on until eventually the progeny will be almost pure wisent. Animals of this category should be kept segregated and never allowed to mingle with purebred animals.

In regard to this method the following comments may be offered:

There always is the possibility of contagious disease or other accident (witness the total loss of the von Beyme herd), whereby a proportion of the existing purebred wisents may be exterminated, and the *Verdrängungszucht* may be regarded, despite opinions to the contrary, as insurance against total loss.

It has become apparent that the surviving wisents of pure blood have a sensitive constitution and do not find in present-day Germany, or Europe, the conditions which best are suited to them. The descendents of the *Verdrängungszucht*, on the other hand, are hardier and exhibit greater stamina and adaptability.

Heck maintains that the *Verdrängungszucht* are not crossbreeds and are not definitely objectionable on this count.

When experiments are being made in new, and therefore possibly unsuitable, territory, it is better to make them with *Verdrängungszucht*, and not to risk the loss of the more valuable purebred wisents.

In developing the *Verdrängungszucht*, only the best pureblood bulls will be used and all male calves destroyed. Many years will be required, but some day there will be large herds virtually indistinguishable from wisents, only stronger and healthier.

Comments regarding purebred wisents are offered as follows:

In Germany there are the following strains (Stämme) of wisents. The oldest and most successful is that of the Berlin Zoo, derived from Lithuania (Bialowies) and Pless. These animals have been maintained uncontaminated for decades and the stock has been transferred to Poland, Sweden, England, and Holland. There have been losses, but the stock is strong and healthy. The second oldest strain is that of Count Arnim-Boizenburg, which lives in an ancient park at Uckermark. At present there are 4 cows (2 of them being calves of 1935), 2 bulls slightly over 3 years, and 1 bull 1 year of age, or 7 in all. They are well cared for and are in thriving condition.

In the wisent park at Springe, Hannover, the animals were bought by the State from Count Arnim. There are 3 mature cows, 2 cows and one bull born last year, and the famous bull Ivan, considered to be the finest individual in existence. There is said also to have been 3 calves added this year, making 10 in all. Springe was founded in 1930 and used first for *Verdrängungszucht*, but the latter were transferred in 1934 to the Schorfheide, and the Springe park stocked with purebred wisents of Boizenburg strain, as stated above. This park has considerable undergrowth and, although not very large, usually is adequate for the support of the animals, which appear to be fed irregularly.

Finally there is the Munich-Hellabrunn park, in which there has been a stock of wisents since 1928, to the present number of 6 individuals.

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THE DENTITION OF LAMBDOTHERIUM

By Ygnacio Bonillas

The genus *Lambdotherium* is well represented in fossil vertebrate collections from Wyoming. Indeed, it is an important index fossil for the Lost Cabin zone in the continental Eocene of North America; but, curiously enough, a complete dentition belonging to a single individual never has been recorded. The description of such a specimen, therefore, seems worthy of record, particularly since the material reveals some important characters that hitherto were uncertain or unknown.

Occurrence—In the vicinity of Tulsa, Wyoming, is exposed the upper part of a series of predominantly red-colored, continental deposits representing the Lost Cabin horizon, and overlain conformably by the Green River shales. These beds are exposed best along the Green River and for a limited distance along the banks of its tributaries. No stratigraphic break appears to exist within the section. The practically complete dentition of an individual of the genus *Lambdotherium* was found about 50 feet below the Green River shales at a point 6 miles north of the Sublette County line and one-half mile west of the Green River. Astragali, a calcaneus, broken vertebrae, and fragments of girdle and limb bones were found associated with the teeth. Scattered teeth of *Lambdotherium* were found elsewhere in the section, together with *Eohippus, Meniscotherium, Coryphodon, Hyopsodus, Heptodon,* a tarsiid primate, and a taeniodont.

Description of Material.—Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$. The upper incisors in specimen no. 1743, C. I. T. Vert. Paleo. Coll., figures 1 and 2, are chisel-shaped, semi-spatulate, slightly procumbent, and are arranged to form a semicircular or parabolic curve. The upper canines are sharply pointed, and of a round-oval base, being slightly compressed laterally. A diastema is present between I^3 and the canine, and also between the canine and P^1. The first premolar has not been recorded previously, leading to the belief that it is absent in *Lambdotherium*. In specimen no. 1743, this tooth is two-rooted, with a simple, single-cusped, laterally compressed crown. The presence of two roots contradicts the belief that this tooth was absent in any individual of the genus. P^2 is three-rooted, with the crown somewhat extended anteriorly. A postero-internal protocone, a faint metacone, and an external cingulum are present. P^3 has a very prominent protocone from which two cross-lophs, bearing accessory cuspules, lead to the paracone and metacone. The latter cusps are of equal size. A strong parastyle is present, but the mesostyle is of incipient size, although distinct. P^4 is similar to P^3, except that the characters are more strongly marked. In this tooth a strong parastyle and mesostyle are present, the cross-lophs and accessory cusps are more prominent, and an internal cingulum is well developed. The molars resemble each other very closely. All have the characteristic oblique, W-shaped ectoloph and a very strong parastyle and mesostyle. The principal cusps are the protocone, metacone, paracone, and hypocone, and the protoconule is fairly large and slightly crescentic. The metaloph is low; the metaconule not distinct. Intermediate styles or buttresses are present on the ectoloph opposite the protocone, and are weakly developed opposite the metacone. The internal cingulum is variably developed, being absent entirely on some molars and fairly strong on others.

The jaw is slender and elongate, not so deep in proportion to length as in some specimens figured by Osborn. A very pronounced diastema intervenes between the canine

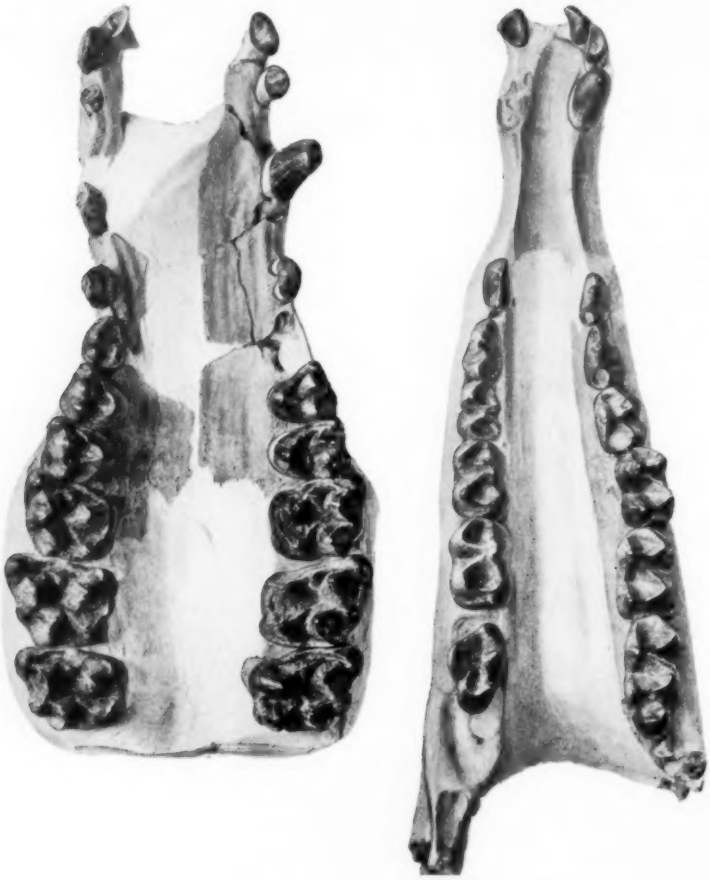

FIG. 1 FIG. 2

Lambdotherium popoagicum Cope

Figure 1, palate with upper dentition. Figure 2, mandible with lower dentition; no. 1743 Calif. Inst. Tech. Vert. Paleo. Coll.; occlusal views, × 1. Lost Cabin Beds, Lower Eocene; Tulsa, Wyoming.

and P_2, the chin being extended at the symphysis. The lower incisors are quite spatulate and chisel-shaped, and have a semicircular arrangement. The lower canines, like

the uppers, are sharply pointed, slightly recurved, and laterally compressed. The first lower premolar, as previously demonstrated, definitely is absent. The second premolar is rather simple, consisting of a large protoconid with small paraconid and hypoconid. In P_3 the metaconid is distinct, although very small; the paraconid is stronger, as also is the hypoconid. The fourth premolar is completely molariform, save for the absence of an entoconid. The molars are quite lophiodont, consisting of protoconid, metastylid and metaconid, hypoconid, and entoconid. A rudimentary talonid is present in the first two molars, and is expanded into a strong crescentic cusp in the third molar.

COMPARATIVE MEASUREMENTS (IN MILLIMETERS)

	L. popoagicum No. 1743 C.I.T.	*L. popoagicum* Type, No. 4863 A.M.N.H.	*L. magnum* Type, No. 17527 A.M.N.H.				
P_2-M_3	72.4	68.7	74	M^1-M^3	40.6	36–34	
M_1-M_3	45.1	42	44	P^1	6.6		
P_2	8.4	7.5	8.5	P^2	8.3	7	
P_3	9.5	9.3	9.5	P^3	9.4	7–7.8	
P_4	9.9	9.4	10.0	P^4	10.0	8–8.5	
M_1	12.5	11.4	12	M^1	13.3	10.3–11.5	
M_2	13.7	12	13	M^2	15.5	10.9–12.0	
M_3	18.4	17.5	18.5	M^3	13.2	11.4–12.0	
Diastema	23.7			Diastema, P^1-C	9.2		
Depth of jaw below M_3 (hyd)	24.8			Diastema, C-I^3	8.5		
P_1-M^3	73.3	58.6		M^1-M^3	27.0	25.0	27.5
P_2-M^3	66.0						

Comparisons and Conclusions.—Five species of *Lambdotherium* have been described; *L. popoagicum*, *L. primaevum*, *L. priscum*, *L. progressum*, and *L. magnum*. The primary basis for specific recognition within the genus is the degree of molarization of the lower premolars. Thus *L. priscum* Osborn has simple, *L. popoagicum* Cope intermediate, and *L. progressum* Osborn sub-molariform lower premolars. *L. magnum* Osborn has the same premolar development as *L. popoagicum*, but is distinguishable on the basis of size. Osborn (Bull. Amer. Mus. Nat. Hist., vol. 41, art. 15, p. 562, 1919) said, "These [lower] teeth exceed in length over all (.074) those of the type of *L. popoagicum* in which the same teeth measure .069". In specimen no. 1743, a similar measurement is .0725, indicating a size intermediate between that of the above two forms. The difference in size does not appear to constitute a valid criterion for specific differentiation.

The type of *L. primaevum* Loomis is featured by a strong cingulum surrounding the individual upper molars, and by the presence of crescentic protoconules, a character shared with *L. progressum*. Because of the varied development of the cingula in the teeth of the Tulsa individual, the strength of the basal ledge may be regarded as an individual character. With only a slightly greater variation than occurs in this specimen, teeth referable to different species could be obtained from the same skull. For example, M^1 (left side) of the Tulsa specimen well might be considered a tooth of *L. primaevum*.

A succession of lower premolar series leading from *L. priscum* through *L. popoagicum* to *L. progressum* is shown in figure 3. The Tulsa specimen (not lettered in figure) has the very rudimentary metaconid and paraconid on P_3, characteristic of an individual of

L. popoagicum, resembling closely *L. priscum*. But the upper teeth are very close to those of specimens referable to *L. progressum*, as figured by Osborn (*ibid.*, figure 2). This resemblance to the latter is attested by the strong development of styles and crosslophs in P^3 and P^4 of specimen no. 1743. Thus the degree of molarization of the upper and lower premolars is an individual rather than a specific character.

The recognition within the genus *Lambotherium* of only one species, with fairly wide range of individual variation, is based on the following reasons; (1) all these forms occur at the same stratigraphic horizon within a narrow geologic zone, (2) the species *L. priscum*, *L. popoagicum*, and *L. progressum* merge into each other by insensible gradations,

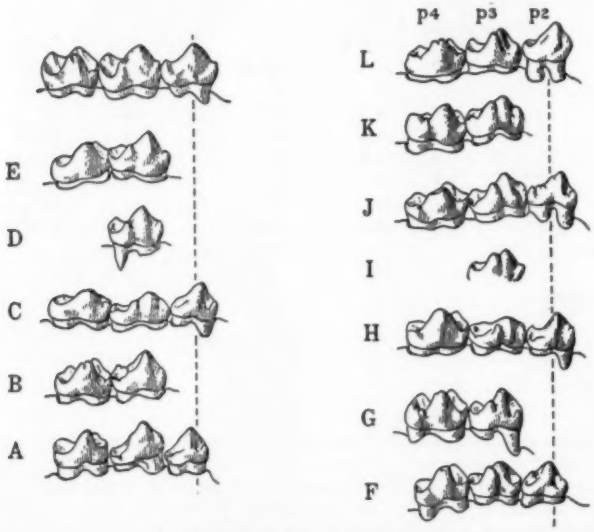

FIG. 3. Lower premolars of three "species" or mutations of *Lambdotherium*. Lettered figures after Osborn. Unlettered figure of specimen no. 1743 C.I.T. Coll. Vert. Paleo. from Tulsa, Wyoming. Natural size.

(3) the upper and lower dentition of the Tulsa specimen shows characters which individually have been regarded as featuring particular species of *Lambdotherium*, (4) it also is of such size as to indicate a gradation from *L. magnum* to *L. popoagicum*, and (5) it has a varied development of the cingulum, the strength of which is the principal character of *L. primaevum*.

The Tulsa individual, as well as all others of the genus, should be referred to *L. popoagicum*. Not only was this the first species described, but its characters are fairly intermediate between the extremes of individual variation.

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SOME HABITS OF A GRAY SHREW IN CAPTIVITY

By Laurence M. Huey

On August 8, 1935, William Eastman, of La Jolla, California, brought to the writer an adult gray shrew (*Notiosorex crawfordi crawfordi*) alive and uninjured. The diminutive mammal, no more than 85 mm. long, had been captured in an electric light globe at the club house of the La Jolla Beach Club. It presumably had descended through the hole for the wire in the ceiling, perhaps attracted by an accumulation of winged insects.

The club-house building is situated just above the high tide line on the southern end of a two-mile sand beach that borders the ocean. Immediately behind this beach lies a semicircular area of alluvial ground, not over a mile wide at its broadest, which contains a few houses and small truck gardens, and is bounded by sharply rising hills clothed with Upper Sonoran plant life. It thus would seem that the gray shrew is tolerant of cool coastal and Upper Sonoran conditions.

Upon arrival at the San Diego Natural History Museum, the shrew was placed in a small glass-walled cage with a floor space of about one and one-half square feet. A shallow covering of sand, a small dish of water and a handful of grass were provided. Reactions to these surroundings were immediate, for the little animal had been confined for about three hours in a glass jar with a padding of green bermuda grass, and its pelage was badly mussed.

It commenced dusting itself with sand and combing its fur with its feet, being equally dexterous with both the fore and hind limbs. Later the fur was licked with its tongue, cat fashion, then carded with the toes. The face was rubbed and scratched—not with the hands, as might be supposed, but with the hind feet, working in unison, one on either side. This action, watched several times, always elicited a smile from the onlooker. The most ludicrous performance was when the shrew wanted its abdomen rubbed. It would then stretch both hind feet out behind, paralleling its tail, and drag itself along rapidly through the sand on its belly, using its front feet for motive power. Twice I saw this done.

When resting it had two postures. One was to curl itself up, much as a dog does; but the most usual position was lying stretched on its side, concealing itself as much as possible under the bit of grass in the cage. When thus reclining, it often indulged in wide-open-mouthed, tongue-stretching yawns, especially after a large meal and a big killing.

The gray shrew's actions when feeding were extremely interesting. Its movements always were quick and direct. It was given a variety of worms and insects found about the garden—Carabidae beetles some three-quarters of an inch in length, earwigs, sowbugs, crickets, garden cockroaches up to one and one-quarter inches in length, large-bodied moths, earthworms and small

caterpillars. The two last never were touched. Sometimes a dozen or more sowbugs and one or two beetles were placed in the cage at the same time. This always caused considerable activity on the part of the shrew, for after a few were killed and eaten it would proceed to kill all the rest.

While sowbugs were eaten with gusto, moths, beetles, earwigs, crickets and cockroaches always were taken first, the preference shown being in the order named. If a sowbug rolled itself into a protective ball, its smooth, hard-scaled surface was impervious to the attack of the shrew; but when it attempted to uncurl and escape, it fell victim, without fail, to the ever-watchful animal. Crickets and cockroaches always had their legs bitten off, before they were killed by crushing the heads. As these insects were fairly large compared to the size of the shrew, and could run rapidly, this method of attack seemed a natural means by which they could be decelerated at capture. The beetles, too, often were swift of foot, but being smaller, did not offer size-resistance, so were followed persistently around the cage until they were overtaken and their heads were crushed.

One evening a black witch moth (*Erebus*) with a wing-spread of about 4 inches and a body size almost as large as that of the shrew, was placed in the cage. This insect proved a little too much for the shrew in spite of its ferocious bravery, so the greater part of the moth's wings were clipped. Even with this severe handicap the moth still was very strong and, as its body was so large, the shrew attacked it by grasping one of its wing stubs, tugging with main strength and hanging on like a bull-dog. Once, in a burst of spirited action, the shrew was pitched half way across the cage. This only caused a more determined attack and the moth finally was killed and eaten.

Another moth, with a body about three-quarters of an inch in length, was placed in the cage. It had lost many of the scales from its wings and was partially disabled. It could fly feebly, however, from one side of the cage to the other. The shrew, apparently by its sense of hearing, kept following the course of the moth until its flight carried it about two inches above the shrew. Then, with almost invisible quickness, the animal sprang and seized the moth in the air, much as a basket-ball player leaps to catch a ball high over his head. A few crunches with sharp-toothed jaws despatched the moth and, as was also the case with the black witch, it was eaten from the ventral side. When the meal was over, there was nothing left of the moth but the horny upper part of the thorax with the wings attached. Beetles always were eaten in their entirety, chewed head first.

One evening a large grasshopper was placed in the cage. No action ensued during the half hour that the shrew was watched, but next morning there remained only two wings to tell the tale. A scorpion also was tried, but neither animal paid any attention to the other and later the scorpion was removed.

This shrew showed no signs of testiness when touched, although it was

handled but seldom. It drank freely of water when fresh, lapping it with its slender tongue. Its eyesight was poor, as was to be expected, but it seemed to have unusually keen ears, as was demonstrated by its aerial sally when catching the moth; and its sense of smell was extremely acute. The latter faculty was noticeable when Carabidae beetles, of which it seemed quite fond, hid among the grass. They always were detected by smell. At such times, the long, attenuated nose came into play, and in pursuit of these insects the shrew dove with great alacrity headlong into the loose sand and among the grass. The pointed nose seemed to penetrate the grass or sand with ease, like the prow of a swiftly moving boat in water. The shrew always was very neat about its toilet and all fecal matter was deposited in a single corner of the cage.

In Dixon's account of a captive gray shrew (Jour. Mamm., vol. 5, pp. 1–6, 1924), it was stated that periods of 48 hours without food elapsed, with no detrimental effect upon the animal. The subject of this paper probably died from the reverse of Dixon's experience, for after 10 days in captivity it was seen to be ill and was found dead the next morning. With little question its demise was due either to too much food or to food of a poisonous nature. There never was a food shortage, for the interest in watching the shrew attack any insect given it kept 3 persons gathering and feeding fresh insects to it regularly.

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A STUDY OF THE BACULUM IN THE GENERA PEROGNATHUS AND DIPODOMYS

By William Henry Burt

The fact that an os penis or baculum is present in many orders of mammals has been known for a long time, and short notes on this bone have appeared in the European literature since the latter part of the eighteenth century. The subject, however, virtually has been neglected by American investigators. Gilbert (1892) and Chaine (1925) have summarized the earlier literature dealing with the os penis and have described and figured this detail in representative species of most of the following orders: Marsupialia, Chiroptera, Insectivora, Carnivora, Cetacea, Rodentia, and Primates. Thomas (1915) proposed the name "baculum" for the os penis and was the first mammalogist to accord it value as a taxonomic character. Pocock (1923) used it in his classification of the Sciuridae, and demonstrated that it could be utilized to good advantage in determining the classification of this group of rodents, in which skull and skin characters often do not prove of great value. Perhaps, however, he over-estimated its importance in taxonomy. Vinogradov (1925),

reporting on Dipodidae and Zapodidae, and Argyropulo (1929), on the Murinae, have utilized to good advantage the characters of the baculum in their studies.

Lack of interest and insufficient material no doubt have contributed to the meager knowledge of the baculum of North American mammals. The only description I can find of the bone in either *Perognathus* or *Dipodomys* is a short account and rather poor illustration for *Dipodomys agilis* by Tullberg (1899, p. 316, pl. 50).

During the past few years I have saved the bacula of all species of mammals that I personally have collected. In addition I have enlisted the aid of others, among whom should be mentioned particularly Laurence M. Huey, Arthur G. Barr, Jr., Luther Little, Seth B. Benson, and Burton T. Ostenson. For this help I wish to state my appreciation.

For the present report I have had available for study 130 specimens from 15 species (31 subspecies) of the genus *Perognathus* and 46 specimens from 11 species (16 subspecies) of the genus *Dipodomys*. The drawings were made by myself with the aid of a binocular microscope, and all measurements of the bones also were made under binoculars with small dial calipers graduated to one-tenth millimeter. Three measurements were taken as follows: Greatest length (in this measurement the jaws of the calipers were held at a right angle to the shaft of the bone; in bacula that are curved, the actual length of the bone thus was not obtained); greatest dorso-ventral diameter at proximal end or base; and greatest lateral diameter at base. In the table of measurements the average lengths of head and body of the individuals from which the bacula were taken also are included.

The variation in the bacula of adult individuals of a given race of either of the genera here considered is not great, either in size or in general proportions. There is considerable age variation, however, for the baculum seems not to be fully developed until the animal is adult. Bacula of young individuals are smaller with less bulbous basal ends than are those of adults.

In the genera *Perognathus* and *Dipodomys* the characters of taxonomic value to be found in the bacula are general shape and relative proportions. Some species or even subspecies readily may be separated by this element alone, but this does not hold true for all the forms herein considered. The real value, therefore, seems to be in species-grouping within a genus. The baculum is situated internally where it is not subjected to the same modifying influences of stresses and strains as are the bones of the limbs and skull. Its true character, therefore, is less likely to be disguised by extraneous factors. If this be true the characters of the baculum should indicate to a greater extent the real affinities of the animal.

In his revision of the genus *Perognathus*, Osgood (1909), using only skin and skull characters, was somewhat uncertain regarding the relationships of the three species *baileyi*, *formosus*, and *hispidus*. Grinnell (1922) likewise found

it difficult to group the species of the genus *Dipodomys*. It is hoped that the data on the bacula herein presented will help in solving some of the problems of relationships within these two genera of rodents.

Perognathus.—According to the general shape of the baculum the pocket mice of the genus *Perognathus* fall naturally into 4 or perhaps more assemblages. The *parvus* group is not represented in my material and may constitute another group. Subdivision beyond this point seems not to be warranted by the characters displayed by the baculum alone. In other words, characters portrayed by this element apparently are of generic or specific, but not of subspecific, value. Certain species, to be sure, readily are distinguishable by this element alone, but the character here usually is size and not structure, and is not dependable in all cases.

Osgood (1909, p. 12), the latest reviser of the genus, divided *Perognathus* into two subgenera, "*Perognathus* proper, including the small soft-haired species, and *Chaetodipus*, containing the large coarse-haired and long-tailed forms." Osgood further stated that "All the species except three fall naturally into one or the other of the two subgenera. One of these (*formosus*) is a *Perognathus* with strong inclination toward *Chaetodipus;* another (*baileyi*) presents the reverse case; and the third (*hispidus*) must be classed as a *Chaetodipus*, though it is aberrant in some ways." From a study of the bacula of *formosus* and *baileyi* it seems that these two species do not belong with those now allocated to the subgenera *Perognathus* or *Chaetodipus*, but constitute a separate group.

Perognathus hispidus also is distinct in this respect from all other forms, and belongs in a group by itself. It is not the object in the present paper to erect a new subgenus, but instead to indicate the possible value of this element in conjunction with other fundamental structures in building a system of classification.

The first group to be considered is represented by the species *formosus* and *baileyi*. In these two species the baculum has a relatively small proximal end that is more or less circular in cross section (the lateral diameter may be slightly greater than the dorso-ventral diameter in *formosus* or the reverse in *baileyi*). From the slightly enlarged basal portion the bone tapers gradually to the slender shaft, which has a slight upward curvature terminating in a point with a slight ventral inclination, but not forming a distinct hook (figs. 1D, and 1G-1I). In structure, the bacula of this group are simplest and apparently least modified of all the members of the genus *Perognathus*. The baculum of *formosus* differs from that of *baileyi* chiefly in having more slender proportions and a relatively smaller proximal end.

Of the small, soft-haired forms of the subgenus *Perognathus*, I have bacula of the 5 species *flavescens*, *flavus*, *amplus*, *inornatus*, and *longimembris*. In these the baculum is relatively large at the proximal end and the lateral diameter is greater than the dorsoventral diameter, so that in cross-section the

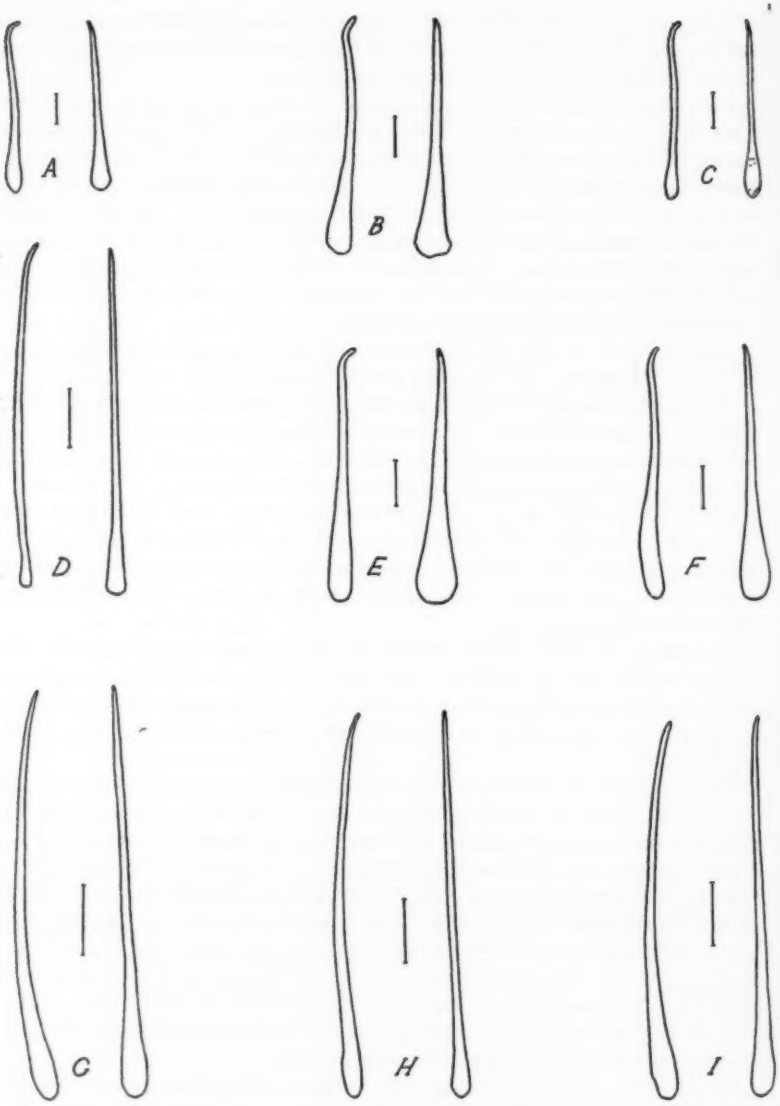

FIG. 1. Lateral and ventral views of bacula of *Perognathus*. A, *P. longimembris pacificus*, x6; B, *P. flavus*, x6; C, *P. flavescens*, x5; D, *P. formosus*, x6; E, *P. amplus taylori*, x6; F, *P. inornatus neglectus*, x6; G, *P. baileyi baileyi*, x6; H, *P. b. eztimus*, x6; I, *P. b. fornicatus*, x6.

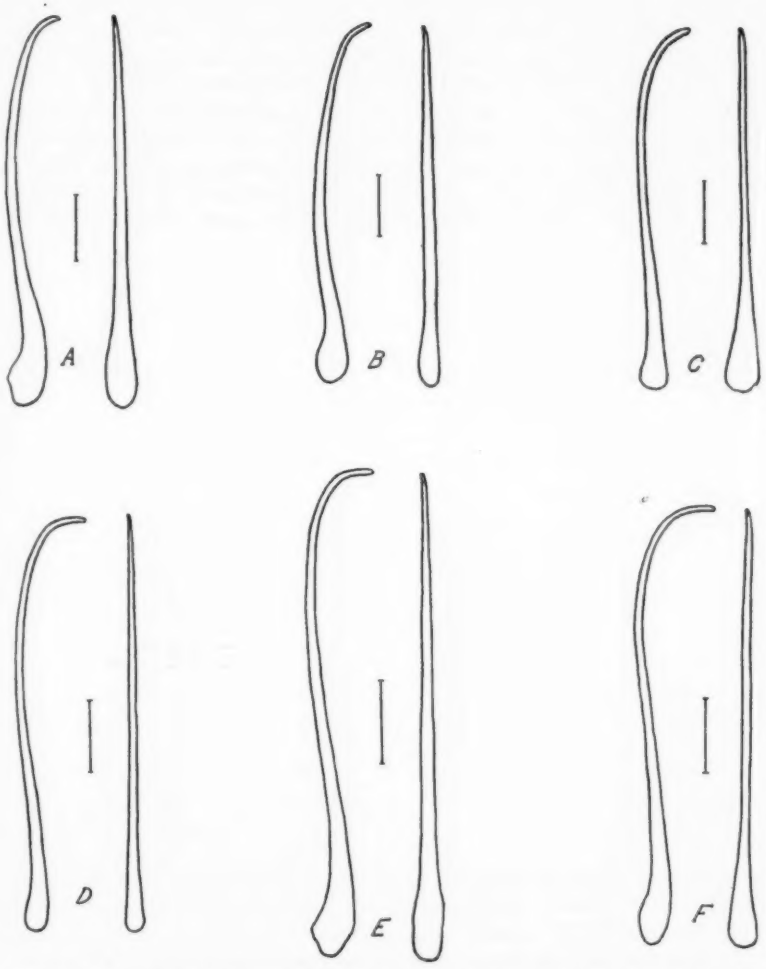

FIG. 2. Lateral and ventral views of bacula of *Perognathus*, all x6; A, *P. arenarius arenarius*; B, *P. a. albulus*; C, *P. penicillatus minimus*; D, *P. p. seri*; E, *P. p. pricei*; F, *P. p. angustirostris*.

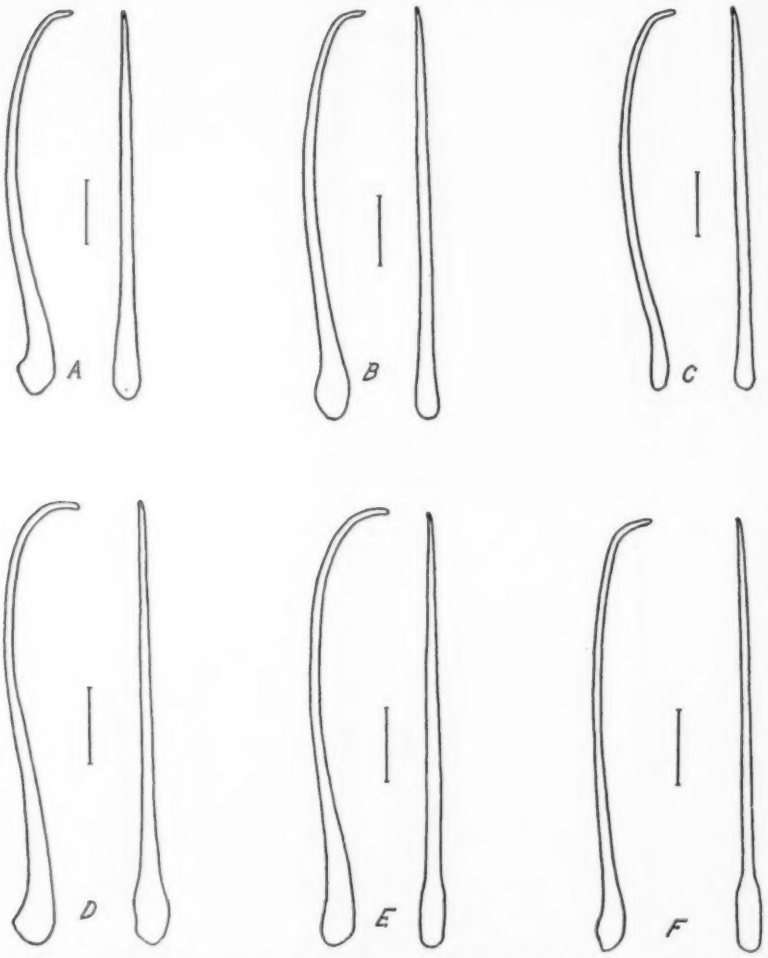

FIG. 3. Lateral and ventral views of bacula of *Perognathus*, all x6. A, *P. spinatus evermannii;* B, *P. californicus dispar;* C, *P. c. bernardinus;* D, *P. intermedius intermedius;* E, *P. spinatus guardiae;* F, *P. s. spinatus.*

basal portion is flattened dorsoventrally. The bone tapers distally to the slender shaft, which curves slightly ventrally and then dorsally. It terminates in a point with a ventral inclination forming a distinct hook on the

laterally flattened distal end (figs. 1A-1C, 1E, 1F). The bacula in this group vary somewhat in size, but the general shape is similar in all forms.

In the third group of the subgenus *Chaetodipus*, bacula are at hand for the species *penicillatus*, *arenarius*, *californicus*, *pernix*, *intermedius*, *artus*, and *spinatus*. From the enlarged basal portion of the baculum, which usually is slightly compressed laterally in these forms, there is a fairly sharp ventral curvature, and then a more gradual curve dorsally. The distal end curves ventrally again, at an angle of about 90 degrees, so that the bone, viewed from the lateral aspect, is roughly sigmoid in outline. The shaft tapers gradually from the base to the distal end (figs. 2A-2F, 3A-3F, 4A, 4B).

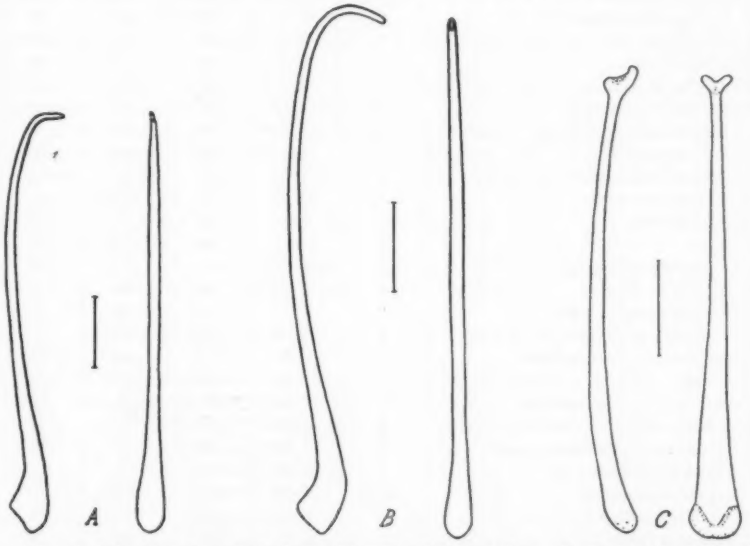

FIG. 4. Lateral and ventral views of bacula of *Perognathus*. A, *P. pernix*, x6; B, *P. artus*, x6; C, *P. hispidus*, x5.

The variation in the bacula in this group is chiefly in relative size of the basal portion and amount of curvature of the bone. There also are slight specific differences in size and in relative proportions. The distal end may curve abruptly downward as in *pernix*, *intermedius*, *artus*, and *spinatus*, or it may have a more gentle downward curvature as in *penicillatus*, *arenarius*, and *californicus*.

In the *hispidus* group the baculum deviates strikingly in structure from that of the other 3 groups. It is a fairly heavy bone only slightly curved, and tapers gradually from the proximal to the distal end as in *baileyi*. Instead of ending in a point, however, there is a definite keel on the dorsal portion of the

distal end, and two processes project ventrolaterally, giving the bone, in end view, a trifid appearance (fig. 4C).

AVERAGE MEASUREMENTS, IN MILLIMETERS, OF BACULA AND OF HEAD AND BODY OF SPECIMENS OF THE GENUS PEROGNATHUS

SPECIES	NUMBER OF SPECIMENS	LENGTH OF BACULUM	DORSO-VENTRAL DIAM. OF BACULUM BASE	LATERAL DIAMETER OF BACULUM BASE	LENGTH OF HEAD AND BODY
P. formosus formosus	4	8.88	.35	.53	—
P. baileyi baileyi	1	11.0	.70	.675	108
P. baileyi extimus	2	10.6	.675	.538	91
P. baileyi fornicatus	2	10.0	.637	.67	93
P. flavescens	1	5.5	.36	.51	61
P. flavus flavus	1	6.25	.60	.95	52
P. amplus taylori	1	7.1	.70	1.00	65
P. inornatus neglectus	9	6.12	.666	.844	74
P. longimembris pacificus	5	4.7	.373	.42	55
P. l. panamintinus	1	4.3	.30	.375	59
P. penicillatus pricei	3	12.58	.95	.98	81
P. p. angustirostris	4	10.69	.71	.781	—
P. p. minimus	1	9.75	.65	.80	65
P. p. seri	9	10.17	.544	.531	74
P. arenarius arenarius	5	9.88	.81	.735	64
P. arenarius albulus	4	9.48	.819	.65	65
P. arenarius sublucidus	5	9.14	.515	.49	70
P. californicus dispar	1	10.85	.825	.625	—
P. californicus bernardinus	2	9.76	.412	.437	73
P. perniz rostratus	1	11.05	.975	.725	73
P. intermedius intermedius	1	11.9	1.0	.95	76
P. artus	6	13.67	.891	.771	84
P. spinatus magdalenae	9	10.5	.475	.52	79
P. spinatus spinatus	2	10.82	.70	.75	78
P. spinatus guardiae	16	11.02	.92	.695	76
P. spinatus pullus	4	9.35	.425	.475	77
P. spinatus lambi	2	11.35	.80	.80	79
P. spinatus evermanni	1	10.1	.90	.70	76
P. spinatus bryanti	4	9.51	.398	.413	74
P. spinatus marcosensis	3	9.58	.47	.45	73
P. hispidus	1	14.8	.9	1.6	107

Dipodomys.—The kangaroo rats studied may be segregated into three groups, according to shape and relative proportions of their bacula. One comprises the *heermanni*, *agilis*, and *ordii* groups, as arranged by Grinnell (1922); another the *merriami* group; and the third includes the *microps*, *deserti*, and *spectabilis* groups. These groups coincide with the arrangement given by Grinnell, with the exception of the *agilis* group. The latter, I believe, should be placed next to the *heermanni* group, instead of being separated from it by the *ordii* and *merriami* groups. Grinnell admitted the

difficulty in arranging the kangaroo rats when he said "It is impossible to build a 'natural' key that will allocate all the species correctly under these groups. It is the special aggregation or combination of characters which goes to form the concept of any group in one's mind. The following synopsis of the groups is offered with due appreciation of the vagueness appertaining to the diagnoses."

The fact that the baculum in the *agilis* group is so similar to that in the *heermanni* group naturally led to a critical examination of the characters presented for the two aggregations. I have arranged the characters, as given by Grinnell, in two columns, so that they may be compared more easily.

D. heermanni group	*D. agilis group*
1. Kangaroo rats of medium to very large size.	1. Kangaroo rats of medium to large size.
2. Maxillary arches very broad, widely spreading, as a rule with postero-external angles prominent and sharp.	2. Maxillary arches rather narrow, narrowly spreading, as a rule, weakly angled.
3. Rostrum heavy to fairly slender.	3. Rostrum relatively heavy.
4. Bullar inflation relatively small to moderately great.	4. Bullar inflation moderate to great.
5. Supra-occipital and interparietal very broad to rather narrow.	5. Supra-occipital and interparietal broad to rather narrow.
6. Tail variable, relatively very long to rather short, in any event of moderate thickness.	6. Tail rather long and of moderate thickness.
7. Ear relatively small to moderate in size.	7. Ear large to largest.
8. Hind foot relatively heavy.	8. Hind foot heavy.
9. Claw and phalanges of first toe on hind foot either present or absent, but metatarsal, at least, of this toe always (so far as known) well developed, relatively speaking.	9. First toe and its claw, on hind foot, usually present, claw and phalanges sometimes missing, but metatarsal always (so far as known) well developed.

It will be seen, I think, that after all, the differences between Grinnell's *heermanni* and *agilis* groups are not very great. The close relationship of the two is attested by the similarity in the construction of the baculum.

In the material at hand not all of the species of kangaroo rats are represented by the baculum, but this element is available for at least one species in each group of the California species, and also for *spectabilis* from Arizona.

The first major group contains the *ordii*, *heermanni*, and *agilis* groups of Grinnell and is represented by *D. o. ordii*, *D. heermanni swarthi*, *D. mohavensis*, *D. leucogenys*, *D. ingens*, *D. a. agilis*, and *D. a. simulans*. In each of these species the baculum has a relatively large basal or proximal end and the bone tapers gradually to the distal end, which curves gracefully downward in *ordii*, *swarthi*, and *mohavensis*, and more abruptly in the other species (figs. 5A-5F).

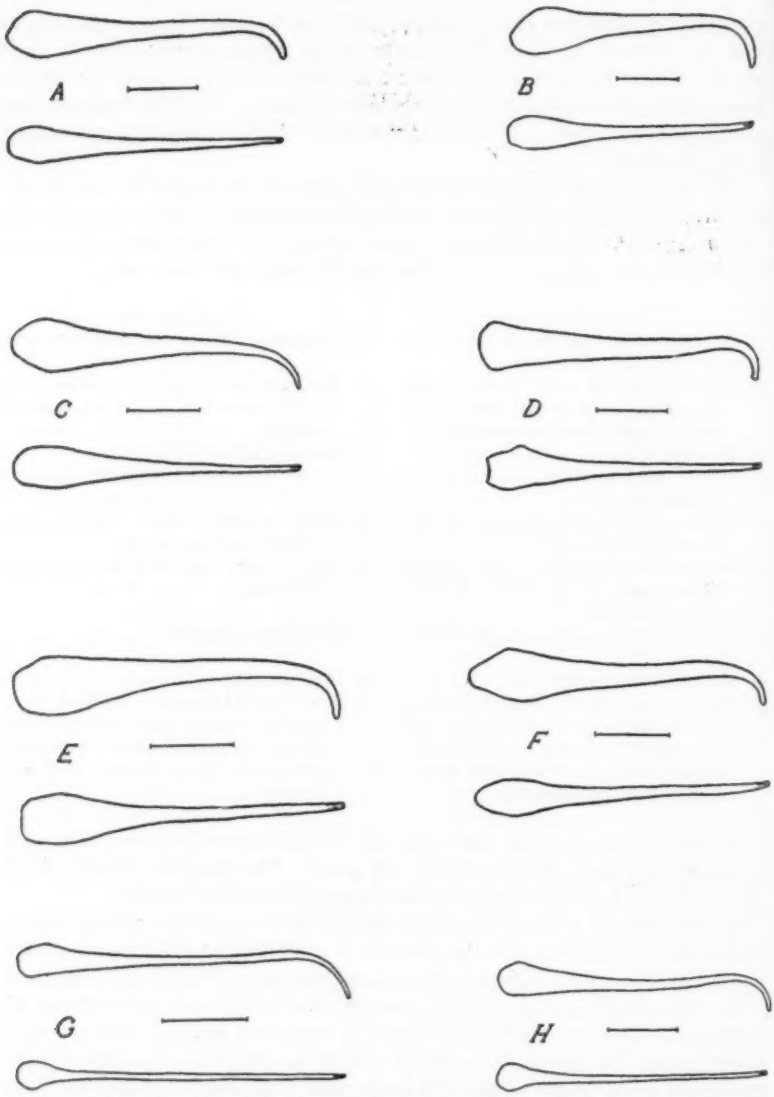

FIG. 5. Lateral and ventral views of bacula of *Dipodomys*, all x4. A, *D. mohavensis*; B, *D. a. agilis*; C, *D. o. ordii*; D, *D. leucogenys*; E, *D. ingens*; F, *D. heermanni swarthi*; G, *D. n. nitratoides*; H, *D. m. merriami*.

The second major group is the *merriami* group, with the two species *merriami* and *nitratoides*. In these two species the baculum is long and slender.

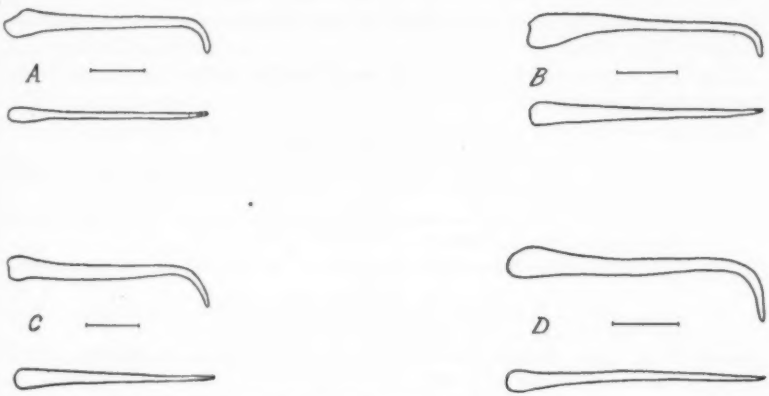

FIG. 6. Lateral and ventral views of bacula of *Dipodomys*, all x4. A, *D. microps levipes;* B, *D. deserti;* C, *D. microps microps;* D, *D. spectabilis perblandus.*

AVERAGE MEASUREMENTS, IN MILLIMETERS, OF BACULA AND OF HEAD AND BODY OF SPECIMENS OF THE GENUS DIPODOMYS

SPECIES	NUMBER OF SPECIMENS	LENGTH OF BACULUM	DORSO-VENTRAL DIAM. OF BACULUM BASE	LATERAL DIAMETER OF BACULUM BASE	LENGTH OF HEAD AND BODY
D. ordii ordii	2	11.366	1.95	1.5	110
D. heermanni swarthi	5	11.2	2.015	1.437	124
D. mohavensis	3	10.76	1.7	1.282	122
D. leucogenys	1	11.1	1.825	1.6	129
D. ingens	2	12.7	2.1	1.875	147
D. agilis agilis	2	9.62	1.6	1.31	—
D. agilis simulans	1	9.15	1.625	1.4	—
D. merriami merriami	8	11.022	1.306	1.044	99
D. merriami melanurus	3	8.09	.72	.55	90
D. merriami mitchelli	3	10.23	1.292	.992	103
D. nitratoides brevinasus	7	13.38	1.132	.918	102
D. spectabilis perblandus	1	10.35	1.2	.75	133
D. microps levipes	2	8.4	.937	.737	105
D. deserti deserti	1	9.5	1.2	.925	147

The slightly enlarged basal end tapers to the slender shaft, which terminates in a downward-curving point (figs. 5G, 5H).

The third major group comprises the *deserti*, *microps*, and *spectabilis* groups, and is represented by all 3 species. In these forms the baculum is relatively

small as compared to that of other kangaroo rats. The basal end is enlarged only slightly in *microps* and *spectabilis*, and somewhat more in *deserti*. The shaft of the bone is relatively thick for its length, and the distal end curves downward into a relatively long hook in *microps* and *spectabilis*, but shorter in *deserti* (figs. 6A-6D).

From the baculum alone it does not seem feasible further to subdivide the species groups as listed above.

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A WALTZING MUTATION IN THE WHITE RAT

By Helen Dean King

Although the waltzing character in mice has been known for a century or more, it has been reported in rats only by Bonhote (1912) and by Hagedoorn and Hagedoorn (1922). Bonhote obtained 4 waltzing rats in the F_2 generation of a cross between *Rattus tectorum* and *Rattus alexandrinus* which had been caught wild in Egypt, but he gave no information regarding their breeding or behavior. Hagedoorn and Hagedoorn later acquired some of Bonhote's hybrid rats and crossed them with several other varieties of the *Rattus rattus* group for a study of coat color inheritance. In the course of these experiments a number of waltzing rats were obtained and several of them were used for breeding tests, but there was offered no explanation for their appearance. From the meager evidence available it seems probable that the waltzing character was introduced into the Hagedoorns' stocks through the matings made with the hybrid rats received from Bonhote, and that it did not constitute a new occurrence of the mutation.

The purpose of the present paper is to record the appearance of a waltzing mutation in a strain of albino *Rattus norvegicus*, and to present data on the breeding and behavior of these rats, obtained during the 3 years that they have been under observation. In 1927 albino mutants appeared in the colony of wild gray Norway rats maintained at the Wistar Institute, Philadelphia, for more than 8 years. These rats served as a foundation stock for a strain of mutant albinos that was developed for the purpose of determining how life processes in these rats differ from those in "stock" albinos, of unknown origin, maintained in captivity for many years. The first waltzer, a female, was born in the fourth generation of this mutant albino strain in July, 1932. Some 5000 individuals were born in this strain prior to the appearance of the waltzer and several hundred of them were reared for a study of their life processes. None of them ever exhibited behavior that was other than normal, nor have other waltzers appeared in later years, although the strain always has been closely inbred, usually by brother-sister matings.

Aside from her bizarre movements, the first waltzer apparently was normal in all respects. She was mated with a non-waltzing brother and cast a total of 12 litters, comprising 78 young (46 males and 32 females), of which 3 were stillborn and 1 died when two days old. All the 74 living young were reared by their mother, who gave them excellent care. Only 2 males and 1 female were waltzers. Soon after the birth of her last litter the mother was found to be suffering from lung infection and was killed in December, 1933. An autopsy disclosed no obvious abnormality in any organs other than the lungs. Sibs of the waltzer, when inbred, produced only normal young.

Each individual of the F_1 generation reared was tested at least 3 times at intervals of several days, when from 15 to 30 days old, in order that there

might be no uncertainty regarding its status as a waltzer. When one has become familiar with the characteristic movements of the young waltzer there never is any doubt of the classification of an individual, as Gates (1926) stated to be the case with waltzing mice. If the character is not shown before the end of the suckling period it evidently never appears, since, in the waltzing strain, many individuals classed as normal have been kept until they were one year old and none of them ever has exhibited waltzing movements.

Breeding tests thus far made with waltzing rats are summarized by generation groups in table 1. The data given include only individuals that lived sufficiently long for determination of their status as waltzers. In the various kinds of matings indicated, *w* is used to designate a waltzer and *W* a non-waltzing or normal individual.

TABLE 1

Breeding data, summarized by generation groups, for waltzing albino rats

GENERATION OF BREEDING RATS	MATINGS	NO. LITTERS	NO. INDIVIDUALS	MALES	FEMALES	WALTZERS		PER CENT WALTZERS
						Males	Females	
P	w × W	12	74	43	31	2	1	4.05
F_1	w × w	1	4	2	2		1	
F_1	W × w	1	5	2	3		2	
F_1	W × W	20	137	70	67	1		
F_2	W × w	3	20	8	12			
F_2	w × w	8	43	21	22	10	16	60.46
F_3	w × w	12	70	33	37	15	25	57.14
F_4	w × w	11	70	36	34	24	31	78.57
F_5*	w × w	23	131	69	62	50	51	77.09
F_6*	w × w	11	57	27	30	24	29	92.98
		102	611	311	300	126	156	46.15

The one waltzing female in the F_1 generation, mated with a waltzing brother, cast 18 young, of which only 4 were reared; 3 were normal and 1 a waltzer. The same male, mated with a non-waltzing sister, sired a litter of 5 young of which 2 were waltzers. Matings between normal F_1 individuals gave only 1 waltzer among 137 young. The 3 litters obtained from the mating of a normal F_2 female with a waltzing brother contained no waltzers, but litters from waltzing parents of this generation had over 60 per cent of waltzing young (Table 1). Since the second generation, all matings in this strain have been between waltzers only, and the percentage of waltzing young has tended to increase as the generations advanced.

The data given in table 1 show that waltzing rats have not always bred true to type even in the fifth and sixth generations, and that normal individuals have produced both normal and waltzing young. Overlapping with normal occurred also in the breeding tests with waltzing rats made by Hagedoorn and

Hagedoorn (1922), and has been found in experiments with waltzing mice (Darbishire, 1903, 1904; Dice, 1935), "circling" mice (Laanes and MacDowell, 1935), as well as in investigations on the inheritance of other anomalies in rodents (Little and Bagg, 1924; King, 1931). In linkage experiments now in progress, waltzing rats have been crossed with many different mutant varieties and in no instance have any F_1 individuals shown the waltzing character, although waltzers have appeared in the F_2 generation of all crosses. It is evident from the above findings that the waltzing character in rats is recessive to normal, as it is in mice. It does not appear, however, in the 1:3 ratio as expected. Available evidence seems to indicate that waltzing is due to a single gene, but that the extent to which this gene expresses itself depends upon modifying factors which favor or inhibit its action.

Castle and Phillips (1914) have shown that the hooded pattern in rats can be changed in a plus or in a minus direction by selection. Selective breeding seems equally effective in increasing the manifestation of the waltzing character, as there has been a marked change in the time of the appearance of waltzing movements, and in their extent, since it became possible to select for breeding the most vigorous waltzers in litters containing only waltzing young. Until the fourth generation the great majority of waltzers did not begin circling until after their eyes were opened, at about the sixteenth day of postnatal life. In later generations the peculiar swaying movements of the head, indicative of a waltzer, have been observed in rats not more than 10 days old, and whirling has begun when the individuals were from 13 to 15 days old. Adults of later generations waltz far more energetically and more persistently than did those of the early generations, which were relatively inactive during morning hours and began vigorous whirling only after their daily feeding at two o'clock.

Although the eccentric movements of waltzing rats are very similar to those of the waltzing mouse as described by Yerkes (1907) and others, I have been informed by those familiar with the Japanese waltzer, as well as with the more recently discovered house mouse mutations known as "shaker" (Lord and Gates, 1929) and "circling" (Laanes and MacDowell, 1935), that in behavior my waltzers resemble the circlers rather more closely than they do other waltzing mice. It is to be understood, accordingly, that I use the term "waltzing" as applied to the Norway rat in a general sense, without implying that it is the exact physiological or genetic equivalent of any of the 3 "waltzing" gene mutations of mice.

In the course of their activity waltzing rats may whirl rapidly in a small circle for several seconds, and then run in loops, large circles or in the figure eight. Occasionally they circle many times around a cage mate that usually remains perfectly quiet during the performance. Adult waltzers, when disturbed, tend to run wildly about the cage, making few circling movements. If they escape from the cage they easily are caught, as they pause every few

feet to whirl vigorously for a few seconds and seem incapable of running any distance in a straight line. Females, as a rule, are more energetic waltzers than are males and all individuals are more active in the afternoon than during the morning.

The age of the individual seems to have a pronounced influence on waltzing movements. Rats are very vigorous waltzers when young, but as they grow older they waltz less frequently and their whirling movements are of shorter duration. Old rats become very sluggish and seldom make more than a few circling movements at any time during the day.

The 3 types of waltzers which Yerkes described in the mouse also are found in the rat: (1) individuals that whirl predominately to the right; (2) those that move chiefly to the left; (3) the mixed type, rats that circle in both directions. To these can be added a fourth type, the vertical waltzer, as in the seventh generation there has appeared a female that makes relatively few horizontal circles but jumps against the side of the cage and turns a complete back somersault, landing on her feet to repeat the same movement several times in succession. Similar somersault movements also have been reported in "circling" mice.

Until the fifth generation the majority of the waltzers either were right or left whirlers; the mixed type of waltzers has tended to predominate in later generations. No attempt has been made, as yet, to determine whether any particular type of waltzing in rats is inherited. Breeding experiments to test this point in mice, made by Yerkes, did not give positive results, although Yerkes considered it probable that the pure waltzer regularly inherits a tendency to whirl to the left, but that this tendency may be obscured by crossing with another variety.

Waltzing rats, in general, are very nervous, irritable and pugnacious, and they are far more difficult to care for than are the other rats in the mutant strain from which they came. When members of a litter are housed together until adulthood, one male, usually the largest, almost invariably kills all of his brothers, although females are not molested. It is impossible to keep young of mixed sexes in a cage with their parents after they are 6 weeks old, as the young males then are killed by their sire. Female waltzers are not quite as vicious as males, and sisters live amicably together; but they promptly attack and kill any strange female that is put into their cage. To avoid the loss of valuable stock it has been found necessary to keep only 1 male and not more than 3 females in a breeding cage, and to remove the young at the end of the suckling period. If there be more adults in the cage it is impossible for a female to rear her young because the nest constantly is disturbed by the activity of the inmates.

Waltzing rats are not as prolific as are rats in other strains under investigation, and their reproductive life is shorter, comprising about 12 months as compared with an average of 15 months in the Norway strain generally.

Data for all litters so far recorded give 6.3 as the average litter size, which is about 0.7 less than the norm for gray and albino litters. There is a very marked individual variation in the reproductive ability of waltzing females. Some females are sterile, although seemingly in good physical condition; others cast 1 or 2 litters and then stop breeding. Many females build a nest and suckle their young for a few days but refuse to care for them longer if the nest has been disturbed when cleaning the cage. Only a few waltzing females have cast more than 6 litters and none of them ever has had as many offspring as had the first waltzer obtained. The maternal instinct is not equally well developed in all females. Some few, like the first waltzer, are excellent mothers and care for their young until the end of the suckling period. Others never show the slightest interest in their offspring. The young rarely are killed and eaten, but they are scattered about the cage and die of exposure and starvation unless given to a foster mother to be reared. Individuals of the fifth and sixth generations are so very active and nervous that they cannot be trusted to raise their young, and litters are removed from the cage soon after birth and suckled by females from other strains.

Hagedoorn and Hagedoorn (1922) reported great difficulty in the breeding and rearing of waltzing rats. They stated that waltzing females usually kill their young at birth or refuse to care for them, and that while waltzing males can mate with normal females it is seemingly impossible for normal males to mate with waltzing females. The latter complication has not arisen in my work as I have obtained many litters from matings of both waltzing females and waltzing males with normal individuals from other strains.

According to various investigators, waltzing mice, as a rule, are smaller and less vigorous than normal individuals and they are very susceptible to disease. Such lack of constitutional vigor is not evident in rats of my waltzing strain. They grow rapidly, mature when about 3 months of age, and attain a large size when adult. A series of body weight determinations made on 18 males and 21 females when they were about one year old gives the average weight of males as 419.4 grams, and of females as 304.4 grams. No "runts" ever have appeared in the strain, nor any individuals with defective eyes or other malformations. The young rats show no lack of viability. Of the 77 individuals born and not recorded in table 1, 13 were dead at birth, and the others died because they were neglected by the mother, or were not cared for by the foster mothers to whom they were given. It is only in their lower fertility that waltzers compare unfavorably with rats of other strains.

The food requirements of waltzing rats are far greater than those of normal individuals. Gates (1926) found a similar condition in waltzing mice and attributed their excessive nutritional demands to their almost ceaseless activity. Some other factor also must be involved in the case of waltzing rats, since the F_1 individuals obtained by crossing waltzing rats with other varieties eat far more than do normal individuals, although they never make

any circling movements. It is of interest in this connection to note that in man, individuals afflicted with athetosis have enormous appetites and drink large quantities of water. This disease, characterized by constantly recurring spasmodic movements of the hands and feet, is attributable chiefly to a lesion in the basal region of the third ventricle. It seems possible that the whirling movements and constant hunger of waltzers may be caused, in part at least, by a similar lesion.

Deafness seems to be characteristic of most strains of waltzing mice, although Yerkes found that some young individuals responded to sudden high tones and loud noises for a few days during the third week of postnatal life, but that adults did not. The 4 strains of waltzing *Peromyscus* studied by Dice (1935) were found to differ not only in their behavior, but also in their reactions to sound: Waltzers of one strain responded to sound at all ages; those of the other strains were deaf except when very young. Deafness does not seem to be a congenital defect in "shaker" mice, but comes on at the age of 22 to 30 days, and subsequently individuals never respond to sound (Lord and Gates, 1929). "Circling" mice, however, hear perfectly at all ages (Laanes and MacDowell, 1935).

Hearing was normal in the waltzing rats obtained by Hagedoorn and Hagedoorn (1922), and my waltzers likewise appear to hear as well as normal rats, judging from the results of numerous tests made with animals of all ages under conditions that seemed to preclude the possibility that their reactions were attributable to air currents rather than to sound. Sudden sharp sounds always cause a twitching of the ears of young waltzers, even if they make no movements. When adults are lying motionless and apparently asleep they instantly are aroused by the jingling of keys, the clapping of hands or the blowing of a whistle. The sound of the feeding truck, even when it is in a remote corner of the colony, at once calls these rats to the front of the cage for food.

The results of numerous attempts to find a morphological basis for the waltzing movements in mice have been conflicting and inconclusive. Some investigators have reported malformations in the ear structure or degeneration of nerve endings in the semicircular canals. Others, finding the ear structure normal, have attributed the whirling to some defect in the cerebellum. Yerkes (1907, 1907a) stated that both the static and acoustic functions of the ears of waltzers differ from those in normal mice, thus suggesting some peculiar conditions in the semicircular canals and defects in the cochlea. After a review of the literature, Yerkes concluded that the exact physiological nature of waltzing never has been shown, and he considered it probable that no explanation of the activity of waltzers can be given "in terms of the structure of the peripheral or the central nervous system, or of both, but that the structure of the entire organism will have to be taken into account. The dancer's physiological characteristics, in fact, suggest multitudinous structural peculiarities." Although no work on the structural basis of waltzing in mice

has been reported in recent years, Lurie (1934) and Lurie, Davis and Derbishire (1934) have investigated ear structure in waltzing guinea pigs and found degenerative changes in the labyrinth, particularly in the organ of Corti.

An investigation of the physiological nature of waltzing in rats recently has been started, but only preliminary work can be mentioned here. A number of waltzers have been killed when they were about one year old and autopsied in Dr. Donaldson's laboratory at The Wistar Institute. The brain showed no peculiarity in external form and its weight accorded with that in rats of like age from the mutant albino strain. Gates (1926) stated that skulls of waltzing mice are longer and slightly narrower than those of common mice. Measurements of skulls of waltzing rats do not agree with Gates' findings, as length and width are normal. Various body organs, including ductless glands, also were normal in size and in weight. No pus was found in the middle ear, indicating that waltzing movements are not associated with the ear infection commonly found in rats. Results of a histological examination of the ear structure and of the cerebellum will be given in a later paper.

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A NEW OTTER FROM KAMCHATKA

By E. A. Goldman

While reviewing the American river otters and making some general comparisons of material in the U. S. National Museum, a single skull from Kamchatka attracted my attention. It represents a rather young but nearly or quite full-grown individual, apparently normal in every way. In the narrowness of the upper molars and in other cranial details, however, it exhibits differential features in contrast to other Asiatic otters that seem to warrant the segregation of a new form.

It is a pleasure to name the animal for the collector, the veteran naturalist, Dr. Leonhard Stejneger, as a slight measure of recognition of his distinguished services in diverse zoological fields during many years.

Lutra stejnegeri, sp. nov. Kamchatka Otter

Type.—From near Petropavlovsk, Kamchatka; subadult, probably ♂, skull only, no. 49485, U. S. Nat. Mus., collected by Leonhard Stejneger in 1882 or 1883.

Distribution.—Known only from the type locality, but probably ranging wherever conditions have remained suitable on the Kamchatka Peninsula.

Characters.—Closely allied to the widely dispersed geographic races of the Eurasian species *Lutra lutra*, and evidently a member of the same restricted group. Skull very similar in general to that of *Lutra lutra lutra* of Sweden, but apparently smaller, with braincase more rounded and inflated; palate more concave near middle, broader behind molars, the posterior border without the small, spinous, median projection usually present in *L. l. lutra*; dentition lighter; upper carnassial with small anterior cusp less developed and cingulum of outer side slightly concave in outline as viewed from below (nearly straight in *L. l. lutra*); upper molar relatively much narrower, its width near middle less than crown width of upper carnassial (in *L. l. lutra* the upper molar is decidedly broader than carnassial); postero-internal lobe of upper molar less prominent, scarcely differentiated from cingulum; posterior heel of lower carnassial less elevated above cingulum, less trenchant. Similar to that of *Lutra whiteleyi* of Japan in the anteriorly rounded form of the interpterygoid fossa, but apparently differing otherwise in about the same characters as from *L. l. lutra*.

Measurements.—Measurements of the skull of the type are given below, and following, in parentheses, the corresponding figures for the skull of a nearly comparable subadult male of *Lutra lutra lutra* from Sweden: Condylobasilar length, 111.4 (116.9); zygomatic breadth, 64.7 (69.5); breadth of braincase (across mastoid processes), 64.7 (62.8); height of braincase (over audital bullae), 39.5 (40.8); interorbital breadth, 19.2 (21.6); postorbital constriction, 15.3 (16); palatal constriction (behind molars), 13.8 (13.1); maxillary tooth row (alveoli), 32.7 (36.2); crown length (outer side) of upper carnassial, 10.9 (12.2); crown width of upper carnassial, 8 (8.8); crown width (near middle) of upper molar, 7.8 (10.1); greatest crown diameter (diagonal) of upper molar, 10.3 (12.4) mm.

Remarks.—The comparatively close relationship of *Lutra stejnegeri* to *Lutra lutra* clearly is indicated, and the former may prove to be an isolated geographic race assignable to the latter species. It requires no close comparison with *Lutra lutra meridionalis* Ognev of the northern Caucasus, U.S.S.R., nor with any other form known to me. Relationship to *Viverra aterrima* Pallas from the Amur River region, south of the Okhotsk Sea, may be somewhat problematical, but even the generic identity of that animal seems to be uncertain.

U. S. Biological Survey, Washington, D. C.

GENERAL NOTES

BODY TEMPERATURES OF SOME CENTRAL AMERICAN MAMMALS

While collecting material for anatomical study, it was possible for the writers to ascertain the body temperatures of several Central American mammals. All records are rectal temperatures, made with corrected Centigrade thermometers. Most of the animals were wild and had to be etherized before any readings could be made, so the figures presented contain this factor of variability. Each temperature recorded represents a different specimen and usually is the mean of several readings taken over a short period of time.

This work was done at the Barro Colorado Island Laboratory and was supported in part by a grant made by the National Research Council.

TEMPERATURES OF MAMMALS

	SEX	BODY	AIR	TIME	REMARKS
Didelphis marsupialis etensis—Eten opossum	♀	34.3	27.2	P.M.	
	♂	34.4	27.2	P.M.	
	♀	34.5	27.6	P.M.	
	♀	34.2	26.7	P.M.	subadult
Metachirops opossum fuscogriseus—Allen opossum	♀	35.4	26.1	P.M.	young
Metachirus nudicaudatus dentaneus—Brown opossum	♀	34.2	27.2	P.M.	
	♂	35.4	26.1	P.M.	
	♀	35.4	26.1	P.M.	subadult
		30.8	25.6	9:00 P.M.	
Philander?—Woolly opossum	♀	33.7	24.4	P.M.	
Chironectes panamensis—Water opossum	♂	34.8	26.1	8:00 P.M.	young
	♂	25.9	24.4	P.M.	young moribund
	♂	34.6	24.4	11:00 P.M.	
Coendou rothschildi—Rothschild porcupine	♂	35.3	26.7	P.M.	
	♀	35.3	27.8	P.M.	
	♂	35.3	28.0	P.M.	
Bradypus griseus—Three-toed sloth	♀	32.2	25.0	P.M.	
		34.1	25.0	P.M.	young 600 grams
Choloepus hoffmanni—Hoffmann two-toed sloth	♀	34.2	25.0	P.M.	
		35.8	25.0	P.M.	young 667 grams
Cyclopes dorsalis—Two-toed anteater		31.1	26.7	P.M.	
		27.8	23.3	A.M.	
		30.2	25.6	P.M.	
		26.1	25.6	P.M.	one hour under ether

TEMPERATURES OF MAMMALS—*Concluded*

	SEX	BODY	AIR	TIME	REMARKS
Tamandua tetradactyla chiriquensis—Three-toed anteater	♀	35.0	27.2	P.M.	
	♀	35.7	27.6	P.M.	not etherized but held; immature
	♀	34.8	25.0	P.M.	etherized
Dasypus novemcinctus fenestratus—Four-toed armadillo		34.6	26.1	P.M.	
	♀	34.4	26.1	P.M.	
		35.3	27.2	P.M.	
		34.1	27.2	P.M.	moribund

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NOTES ON THE MOLES OF LOWER CALIFORNIA, MEXICO

Without question moles are the rarest mammals found in Lower California. Suitable areas are limited to the summits of two small pine-clad mountain ranges in the northern section of the peninsula, the Sierra Juarez and the Sierra San Pedro Martir.

At the time that H. H. T. Jackson published his "Review of the American Moles" (North Amer. Fauna, no. 38, 1915) there was in museum collections but a single specimen of mole from Lower California, this being the type of *Scapanus anthonyi*. It was named by Allen in 1893 (Bull. Amer. Mus. Nat. Hist., vol. 5, p. 200) and described at length by Jackson in his review (p. 76).

This type specimen has been regarded as peculiar in having but 4 instead of the 5 premolars usual in the several races of *Scapanus latimanus*, the nearest relatives of *S. anthonyi*. The constancy of this character in *anthonyi* has been questioned, and Jackson expressed this doubt in his review.

Since the writer can find in the literature no further records of moles from Lower California, it was unusually good fortune when the San Diego Society of Natural History acquired 2 specimens of the rare *Scapanus anthonyi* in the flesh, through the interest of Robert Scott of San Diego. These individuals were captured at La Encantada, Sierra San Pedro Martir, Lower California, on August 26, 1935. They were prepared by the writer and proved to be a male and a female. Realizing their rarity and the uniqueness of the type, it was with no little interest that the skulls were cleaned and compared. In both specimens the premolar was found to be wanting, confirming this peculiar characteristic of the type, regarded as distinctive of the species.

When they were compared with a series of *Scapanus latimanus occultus* from San Diego County, California, the size difference mentioned by Jackson is not marked, and a series of *anthonyi* might eliminate this as a major character. These two specimens are much darker in color than *occultus* however, and confirm his description in this respect.

Further comparison of *anthonyi* with *occultus* reveals 2 characters that neither Allen (loc. cit.), True (Proc. U. S. Nat. Museum, vol. 19, p. 53, 1893), nor Jackson (loc. cit.) have mentioned when writing about *S. anthonyi*. One is external, the other, cranial. The manus of *anthonyi*, although smaller than that of *occultus*, is proportionately squarer, with broader and heavier phalanges that are armed with wider, heavier nails. This character immediately is evident on inspection. The cranial character lies in the pterygoid bones. Those of *anthonyi* remain parallel to the tips, while the pterygoids of *occultus* tend to approach one another at the tips. These characters are constant in both of the recently acquired specimens of *anthonyi*.

That *Scapanus anthonyi* is confined to the higher parts of the Sierra San Pedro Martir is substantiated by the different identity of a mole in the collection of the San Diego Society of Natural History, that was captured at Laguna Hanson in the Sierra Juarez, Lower California. This is the mountain range just north of the Sierra San Pedro Martir and nearer the International Boundary. This specimen, which hitherto has not been recorded, was submitted to Dr. Jackson, who pronounced it *Scapanus latimanus occultus*.

When making the present comparisons, the writer found but a single tendency shown by this specimen towards *anthonyi*, and that is in the palmation of the front foot. All other characters well matched those of *occultus* from San Diego County. A series from the Sierra Juarez possibly might reveal other tendencies, but with the decidedly well-developed characters now shown in *anthonyi* it seems best that it remain in full specific standing, in conformity with Jackson's treatment of it.—LAWRENCE M. HUEY, *San Diego Society of Natural History, Balboa Park, San Diego, California.*

ESTABLISHED COLONIES OF THE MEXICAN FREE-TAILED BAT IN KANSAS

Heretofore *Tadarida mexicana* (Saussure) has been reported only as an accidental visitor to Kansas. D. E. Lantz (Trans. Kans. Acad. Sci., vol. 20, p. 217, 1907) stated that "a specimen of free-tailed bat was collected at Manhattan by Dr. C. P. Blachly, and sent to Professor Cragin of Washburn, in 1884. Professor Cragin refers to it under the name *Nyctinomus nasutus*. The specimen is probably *Nyctinomus mexicana*, which occurs over much of Texas." A careful check was made at the Washburn College Museum in the spring of 1933, and it was found that this specimen was missing.

The first authentic record for Kansas was a specimen which I shot on the evening of September 6, 1933, at Atnea, Kansas (Hibbard, Trans. Kans. Acad. Sci., vol. 36, p. 234, 1933).

During November, 1933, we visited Henquenet Cave 6 miles southwest of Hope, Dickinson County, Kansas (Haworth, Geol. Surv. Kans., vol. 5, p. 61, 1899). The cave entrance had been blasted shut about 20 years ago. It was learned from the people in the vicinity that before the blasting occurred the bats had inhabited the cave during the summer in large numbers. The bats answered the description of the Mexican free-tail, but no proof could be established.

The second specimen (J. D. Black, Jour. Mamm., vol. 16, p. 147, 1935) was taken October 8, 1934, at Castle Rock on the Gove-Trego county line.

While accompanying a field trip for Charles D. Bunker, Curator, Museum of Birds and Mammals, University of Kansas, into the south-central part of Kansas for the purpose of studying and collecting bats, 3 colonies of *Tadarida mexicana* in the city of Medicine Lodge, Barber County, were visited. We heard again, while working near Atnea, of the large number of bats in the Court House at Medicine Lodge. These were reported to us in the fall of 1933, but because of a detour we were unable to visit them at that time. On our return from the "gyp" caves we stopped at Medicine Lodge, August 31, 1935, and obtained permission to look at the bats in the steeple of the Court House. As we ascended the steps to the steeple the odor of *Tadarida* was apparent and announced their presence in great numbers. The large colony had inhabited the court house for years and the county has gone to large expense in trying to keep them out of the building. Next we visited the old grade school building where the odor likewise was present. The Mexican free-tailed bat, in association with the big brown bat, *Eptesicus fuscus*, was found in large number in the belfry. In the large attic there occurred many free-tailed bats and large piles of guano. The attic is cleaned once a year, but it is impossible to rid the premises of the odor of the bats. A small colony also was found in an old theater on Main Street. Still another was reported as inhabiting the hotel.

It probably is safe to say that established colonies of Mexican free-tailed bats will be found in suitable old buildings throughout the south-central and southwestern portions

of Kansas.—Claude W. Hibbard, *Museum of Vertebrate Paleontology, University of Kansas, Lawrence, Kansas.*

THE STATUS OF VESPERTILIO PILOSUS PETERS

In our revision of the American bats of the genus *Myotis*, Gerrit S. Miller, Jr., and the writer (Bull. U. S. Nat. Mus., no. 144, p. 208, 1928) tentatively included *Myotis pilosus* (Peters), at the same time expressing doubt as to the supposed American origin of the type. This bat originally was described by Peters (Monatsb. K. K. Akad. Wiss., Berlin, p. 403, 1869) on the basis of a female believed to have come from Montevideo, Uruguay, but no other example is known from South America. Even the type itself seems at present to have dropped from sight, although Dobson probably studied it at the Paris Museum when preparing his Catalogue of the Chiroptera in the British Museum (1878). We suggested that after all this might be an Old World species and that the locality as given was erroneous.

Recently, through the kindness of Dr. C. C. Liu, the Museum of Comparative Zoölogy has received a bat from Suchow, lower Yangtse, China, whose characters agree so essentially with the description of *Vespertilio pilosus*, that there can be no doubt of its identity. Dobson, in his key to the bats included in the genus *Vespertilio*, placed *pilosus* in the subgenus *Leuconoë*, which he characterized in part by the relatively large feet and by the wing membrane arising from the tibia or the ankle. The only species, however, in which the origin is from the tibia is *V. pilosus*. In the Suchow specimen the latter character is very clear, for the membrane arises at almost the middle of the ventral aspect of the tibia, leaving the distal part of the leg remarkably free. In addition the tail is rather short, the feet enormous, and with strong and sharply recurved claws as long as the tibia. These details at once suggest fish-eating habits, for parallel conditions occur in the genera *Noctilio* and *Pizonyx* of known piscivorous predilections. The stomach and intestines of our specimen, however, unfortunately were quite empty.

In 1894 Thomas described as *Vespertilio* (*Leuconoë*) *ricketti* what undoubtedly is this same bat, from Foochow, Fukien Province, China, calling attention to the enormous feet, as long as the tibia, the high insertion of the plagiopatagium midway of the tibia, and the long calcaneus. Still later another specimen (without skull) was secured at Shaowu, Min River, Fukien Province by the Asiatic Expeditions of the American Museum of Natural History. No further mention of the species appeared in the literature until 1917, when Bianchi, commenting on the bats of Russia, included it among those which he regarded as constituting the genus *Capaccinius*, at the same time proposing for Thomas's species a new subgenus, *Rickettia*. In view of the distinctive character of the membrane and foot, unique among the bats usually referred to *Myotis* (the *Vespertilio* in part of Dobson), this may as well stand as a full genus. The synonymy of the species then will be as follows:

Rickettia pilosa (Peters)

Vespertilio (*Leuconoë*) *pilosus* Peters, Monatsb. K. K. Akad. Wiss., Berlin, p. 403, 1869; Dobson, Cat. Chiroptera British Mus., pp. 285, 289, 1878. Type locality given as Montevideo, but probably China.

Myotis pilosus Trouessart, Cat. Mamm. Viv. Foss., suppl., p. 89, 1904; Miller and Allen, Bull. U. S. Nat. Mus., no. 144, p. 208, 1928.

Vespertilio (*Leuconoë*) *ricketti* Thomas, Ann. Mag. Nat. Hist., ser. 6, vol. 14, p. 300, 1894. Foochow, China.

Capaccinius ricketti Bianchi, Annuaire Mus. Zool. Acad. Sci., Petrograd, for 1916, vol. 21, p. lxxviii, 1917, as type of the new subgenus *Rickettia*.

While this bat thus is eliminated from the South American list, it possibly is a close ally of the genus *Pizonyx* of the Gulf of California region occurring at about the same northern latitude as the Chinese area of distribution of *Rickettia*. It differs conspicu-

ously from the latter, however, in the detail of the attachment of the wing, which in *Pizonyx* becomes peculiarly narrowed at about the middle of the tibia. Instead of being attached upon the ventral surface at this point, it continues ridgelike to an insertion upon the dorsal surface of the outer side of the metatarsus. In *Pizonyx* the toes are practically naked, but in *Rickettia* the backs of the toes and of the tibiae are obviously hairy, as originally described by Peters. Furthermore, the glandlike structure noted by Miller in the wing membrane of *Pizonyx* between the forearm and the fifth metacarpal, is lacking in *Rickettia*. The teeth of the latter are essentially myotine, but the outer upper incisor has a large inner cusp, the hypocones of the upper molars are very much reduced, and there is no protoconule such as is present in some of the smaller species referred to *Leuconoë*.—GLOVER M. ALLEN, *Museum of Comparative Zoölogy, Cambridge, Massachusetts.*

FOOD HABITS OF THE MINK IN NEW YORK

From 1927 to 1934, the writer gathered mink carcasses (*Lutreola vision mink*) during the trapping season (November 10 to March 15) from widely scattered sources in New York State. Of more than 100 carcasses examined only 70 contained remains in sufficient quantity to make an analysis possible. In such carcasses one frequently finds the stomach empty. Examination of the large intestine usually discloses some indigestible matter which often gives a clue to the species last eaten.

VISCERAL ANALYSIS OF 70 FALL AND WINTER MINK FROM NEW YORK

Kind of Food	*Frequency Indices*
Mice (Chiefly *Microtus*)	32.94
Fish	18.82
Crayfish	16.47
Muskrat	14.12
Rabbits	4.71
Insects	7.06
Frogs	2.36
Mole (*Condylura*)	2.36
Grasses	1.18

The study agrees essentially with that of Dearborn (Foods of some predatory furbearing animals in Michigan, Bull. I, School of Forestry and Conservation, Univ. Mich., p. 32, 1932) in which mammals formed 55.63 per cent of the winter food of 297 mink. The investigations of Dearborn disclosed that muskrats were the most important winter food, while the New York mink took mice more frequently. Little doubt can exist that the mink is the most serious natural predator of muskrats.

That stomach analysis does not tell the whole story is evident from the following incident. On August 6, 1934, Dr. A. A. Allen shot a marauding mink at his home at Ithaca, New York. The previous evening the animal had killed and partly eaten several ducks on his pond. When shot late at night it was giving chase to the remaining birds. The animal was found last to have eaten a small garter snake, while the hind gut held a mass of the fur of the Norway rat.—W. J. HAMILTON, JR., *Cornell University, Ithaca, New York.*

COYOTE AND BULL SNAKE

About 3 o'clock in the afternoon of May 2, 1935, while mapping topography on a small ridge southwest of the Parker Creek Erosion Station in central Arizona, I heard a noise resembling the rustling of dead leaves. A coyote was standing on a dead sotol (*Dasylirion*) and sniffing at it. He jumped down and started to paw the leaves. Suddenly he jumped back and then cautiously approached at a different place. This time he began

to tear apart the sotol with his teeth. He found a hole and stuck his head in as far as he could, then jumped back a couple of feet, looked around, and seeing nothing, began to paw the sotol again. For several minutes the coyote first pawed the sotol and then tore off leaves. Occasionally he jumped back and began at a different place.

While the coyote was working at the sotol I dodged along the opposite side of the ridge and came to a place, at a distance of about 200 feet, where I could see him more plainly. He then was dashing in and jumping back from a scrub live oak bush, coiled and wrapped around the branches of which was a bull snake trying to defend himself.

The coyote dashed in, seized the snake by the tail and dragged it into the open. The snake, which was about four and one-half feet long, prepared for battle by raising its head and part of its body a foot or so above the ground. When the coyote approached too closely, the snake struck at him. The coyote sprang out of the way and snapped the snake just back of the head, jumping away before the snake could retaliate. Every time the coyote came within range, the snake struck at him, and each time the coyote snapped the snake. The last time the coyote did this the snake collapsed. The coyote seized the snake and shook it until it stopped squirming. Being satisfied that the snake was dead, the coyote sat on his haunches and looked around, then started to eat the snake, beginning with the head.

When the coyote had eaten about half of the snake I came into the open and yelled at him. He dropped the snake, then grabbed it in his mouth, ran about 40 feet, stopped, turned around and looked at me for a minute, then went on eating. When he had finished, he trotted off through the brush.—JERRY JOHNSON, *Parker Creek Branch, Southwestern Forest and Range Experiment Station, Arizona.*

BAILEY BOBCAT CONTRIBUTES NEW MAMMAL RECORDS

While the Bailey bobcat (*Lynx rufus baileyi*) is recorded as being fairly common throughout the Grand Canyon region, little information regarding the food habits of the animal in this locality seems to be available. Thus it was with more than usual interest that I heard of a bobcat having been killed accidentally by an automobile near Grand Canyon National Park on May 31. Hoping to obtain data of interest regarding the food habits of this animal, I brought the body in for study. The bobcat was found 26 miles south of the park headquarters building on the south entrance road. It had been killed in an area almost completely devoid of trees or small shrubs, with no natural rock breaks anywhere near to afford protection. This is rather an unusual type of country in which to find this species.

An examination of the stomach contents revealed some very interesting facts. The food had been eaten so recently that the digestive juices of the stomach had not affected it to any marked degree. Thus it was not difficult positively to identify practically all of the types of food represented. Six mice, a kangaroo rat and a rabbit were included in the food mass in the stomach. Either the bobcat was an expert hunter, or food was overly abundant in that locality. Mixed all through the stomach contents were numerous nematodes, most of which were about one and one-half inches in length.

Although I was certain of the rabbit, I was not positive regarding the identity of the mice and the kangaroo rat. Accordingly I sent the best specimens, and the nematodes, to the Bureau of Biological Survey for further identification.

The mammal specimens were identified as *Reithrodontomys m. megalotis*, *Perognathus flavus fuliginosus* and *Dipodomys ordii cleomophila*. These results are highly interesting, because this *Reithrodontomys* is listed in the Grand Canyon region as "inhabiting the bottom and lower parts of the Canyon" (Check-list of Mammals, Grand Canyon Nature Notes, 1930), while *Perognathus f. fuliginosus* is not recorded from the Canyon region. The latter species was reported by Osgood as found on the "Lava beds in the vicinity of the San Francisco Mountain, Arizona." It seems evident that the given

range of this species must be changed to include several miles of territory north of the San Francisco Mountain lava beds. *Dipodomys o. cleomophila* is of especial interest as a subspecies of *Dipodomys* thus definitely is added to the immediate vicinity of the south rim of the Grand Canyon. In addition the record extends the known range of this form much farther north of the San Francisco peaks than has been stated in the past. The rabbit was identified as *Sylvilagus auduboni arizonae*.

The nematodes were identified as *Physaloptera praeputialis*. Worms of this genus are recorded as being very common in many small rodents and carnivores living on the ground.

For the identification of the mammal specimens, I wish to thank Dr. H. H. T. Jackson, Bureau of Biological Survey, while my thanks are due Dr. J. E. Shillinger of the same bureau for the name of the nematodes. To some unidentified tourist, the Wildlife Division of the National Park Service is indebted for this latest contribution to wildlife knowledge in the Grand Canyon region. All unknown to this tourist, he contributed much valuable information that otherwise would have taken weeks to obtain in the field.—Russell K. Grater, *Assistant Wildlife Technician, Grand Canyon National Park, Arizona.*

TERRITORIAL BEHAVIOR AND SOCIAL DOMINANCE AMONG SCIURIDAE

In August, 1932, I was camped with a party in the Park Range near Pearl, Colorado. The gentle slopes around camp were covered by a growth of lodgepole pine of mixed age and density. Here the pine squirrels (*Sciurus fremonti fremonti*) were unusually abundant and active.

Scattered among the trees were many piles of cone scales the larger of which amounted to several bushels. Each pile was near the center of an area an acre or two in extent which was guarded jealously by a single squirrel. Each animal was busy cutting cones and burying the seeds in little hoards among the loose scales. One squirrel radiated in a new direction each time it went for a cone. At intervals a squirrel stopped and gave its characteristic churring call, and frequently a squirrel of a neighboring territory answered. Once 3 were calling in a limited area where their respective territories adjoined. One morning I saw the squirrel that had the territory just back of camp in close pursuit of another squirrel. When the pursued animal dashed across an old wood road the pursuer veered along a fallen log, stopped, churred vigorously, and then returned to its territory.

I gained the impression that with these squirrels the churring served the same purpose as song in the territorial behavior of birds for warning other individuals that the singer was ready to defend its area against invasion. This belief has become intensified with the occasional opportunities which I have had for watching pine squirrels in other parts of the country.

In September, 1934, I was camped near Siltcoos Lake on the Oregon coast. Here the Douglas squirrels (*Sciurus douglasii* subsp.) were behaving in similar fashion. Their territories were even more circumscribed, some covering not more than one-half acre. The squirrel by camp kept carefully within certain bounds. Once while it was snipping off the cones high in a tree an alien squirrel appeared, and presently sneaked to the tree, picked up a cone, and scampered across a stream and a road into its own territory. To the human observer it gave the impression of knowing that it was trespassing.

I spent 3 weeks during June and July, 1935, in camp in the Blue Mountains of eastern Oregon. Two pine squirrels (*Sciurus douglasii albolimbatus*) had their home areas near camp. Once I saw one of them start for a slope covered with dense young growth, stop on a log, and chur. It was answered by another from the trees behind it. Immediately it turned around, returned to the trees, and chased the intruder up the slope on the side of camp opposite its first position.

Three questions are especially insistent. Is the territory occupied and defended throughout the whole year? How is territorial behavior modified during the mating season? How are the young squirrels accommodated; do they settle close at hand, or must they wander far afield until they find unoccupied areas?

At the Blue Mountain camp I baited a log pile in order to attract the golden-mantled ground squirrels (*Callospermophilus chrysodeirus chrysodeirus*) so that I might study certain phases of their behavior. There were 19 marked individuals, although some of them returned only at rare intervals. The log pile was the home of number 5, and she did her best to drive away the others. Some of her sallies were only short, but others were long and tortuous. There were rather definite limits, usually not more than 100 feet from the pile, beyond which she would not extend her pursuit. In spite of the vigor and the number of her chases (one day she made nearly 60 in about 6 hours) she never succeeded in keeping the other animals away. Often, if she stopped to eat on the way back, the pursued animal had returned to the log pile before her.

At a later camp on the North Fork of the Cache la Poudre River in Colorado, a nearby log pile was the home of an adult and 5 young squirrels (*Callospermophilus lateralis lateralis*). The adult defended the pile and its immediate vicinity but when she was more than a hundred feet away, she seemed quite indifferent to other individuals.

At the Blue Mountain camp another form of social behavior became evident shortly after I had marked the golden-mantled ground squirrels. This might be called the chase or dominance order. Number 5, as defender of her territory, was at the head of the order. Only twice did I see another animal dispute her sway, both times over delectable pancakes. Number 10 chased all visitors except number 5; number 2 chased all but 5 and 10; and 4 chased all but 5, 10 and 2. Then in successively lower order came 13, 0, 7, 15 and 11, although there were not enough pursuits observed for determining very exactly the status of this group. Numbers 1, 6 and 12 were at the bottom of the order, and never were observed chasing another animal.

At the Poudre River camp a population of chipmunks (*Eutamias quadrivittatus quadrivittatus*) gave some evidence of a similar chase order. Number 1 chased numbers 2, 5, 8, 26, A and D. Chipmunk J was completely the master of number 1, although she was not seen chasing as many of the others. Number 8 chased A, and 26 chased 31.

The pursuits involved in this social dominance were neither so vigorous nor so long as those in defense of territory. They usually started when two or more animals came together where food was available.—KENNETH GORDON, *Oregon State College, Corvallis, Oregon.*

BREEDING AND YOUNG OF THE GRASSHOPPER MOUSE (ONYCHOMYS LEUCOGASTER FUSCOGRISEUS)

For two years a stock of grasshopper mice, secured from Lind, central Washington, has been kept under observation. During the first year in captivity very little breeding occurred, and the females which did reproduce usually killed and ate their young shortly after birth. The mice were fed on a diet of ground whole wheat, powdered milk and iodized salt, with the addition of green food twice a week. Since the cannibalism of the females indicated a dietary deficiency, a piece of raw beef liver about an inch square was given each mouse once a week. The avidity with which they consumed the liver was so astonishing that this addition to the diet was continued in routine feeding. After this, breeding and the number of litters raised to maturity increased perceptibly.

Perhaps the most difficult information to obtain in studying the breeding habits of wild animals is the period of gestation. As this period varies greatly and usually is influenced by lactation, the time interval can only be set within certain limits. In mating these grasshopper mice a male usually was placed in the cage of a female just before or immediately after the birth of a litter. The next morning the male was removed. Thus

the time of gestation was known within 12 hours. Three gestation periods were obtained by this method. Female 5 had a period of 39 days, during which time she was nursing 4 young. Female 1 had one gestation period of 47 days while nursing a litter of 4 young, and another of 33 days during which she nursed 2 young. Two more gestation periods were obtained, at least as maximum limits, since the males were left with the females during the entire interval. Female 15 was with a male 46 days before a litter was born. Female 14 was placed with a male on February 12, 1935, and on March 26 (32 days later) she gave birth to 2 young. Neither of these 2 females were nursing young. Thirty-two days was the shortest period obtained for a non-lactating female, whereas lactating females varied from 33 to 47 days.

The birth of 10 litters in the laboratory was noted, while several others occurred unobserved during the summer months. The number of young per litter varied from 2 to 5. At birth the young were pink, and hairless except for the vibrissae which were quite evident. Their eyes and ears were closed, and the tails characteristically were short and thick. Twenty-two newly born mice representing 7 litters were weighed and measured. In weight they averaged 2.2 (1.7 to 2.7) grams; total length, 46 (41 to 51) mm.; tail 8.5 (7 to 10) mm.; hind foot, 6.3 (5.7 to 6.9) mm. Within 3 days the ears unfolded and the dorsal parts became pigmented. In 12 days the backs were covered with soft gray fur while the feet and underparts were white. The eyes opened in 19 to 20 days, and at this time they practically were weaned. Three cases occurred in which the female killed one or all of her young a few days after the eyes opened. In each case the female was pregnant and evidently was unable to nurse her offspring longer, using this method of disposing of them. The surviving young were separated from the mothers and were quite able to care for themselves. No doubt in nature the young are evicted from the nest soon after their eyes open. The youngest breeding female was 95 days old when first found pregnant and was still in the soft gray juvenal pelage. The more tawny adult pelage usually appears when the mice are 5 or 6 months old.

Bailey (Life history and habits of grasshopper mice, U. S. Dept. Agric. Tech. Bull. no. 145, 1929) has noted some breeding habits in the *leucogaster* and *torridus* groups of the genus *Onychomys*. He found that young *Onychomys leucogaster melanophrys* from Arizona opened their eyes in 15, and were weaned in about 24 days. Their incisors were well beyond the gums and the ears open by the eleventh day. He aptly described the peculiar call of the grasshopper mice as "a miniature wolf's howl." Its carrying power is remarkable. I have heard it clearly at a distance of at least 100 feet from the closed greenhouse in which the animals were kept. The mouse usually stands on its hind feet with its front feet resting upon a food dish or side of the cage, points its nose skyward and with the mouth wide open emits the shrill, clear, little "wolf's howl." The other sound, which Bailey terms similar to the "barking of a tiny terrier," is entirely different and is used in protest, anger or scolding. I also have heard a high-pitched note which may be called a modified "wolf's howl" of lesser intensity, but of such ventriloquistic qualities that it is very difficult to locate. This note is very similar to that of the harvest mouse.—Ruth Dowell Svihla, *Zoology Department, State College of Washington, Pullman, Washington.*

THE BLACK RAT IN VERMONT

The first week in June, 1935, found me trapping small mammals in a shaded, mountain glen 2 miles east of Wallingford, Vermont. One day a farmer's boy, to whom I had given some mouse traps, told me that he wanted me to see a big rat killed near the house by his dog. To my surprise it proved to be a black rat (*Rattus rattus rattus*), perhaps now of sufficient rarity in New England to be worthy of record.—Morris M. Green, *Ardmore, Pennsylvania.*

NAPAEOZAPUS ON MOUNT DESERT ISLAND

During the summer of 1934, while trapping for small mammals in connection with a survey of the native fauna of Mount Desert Island, Maine, an adult male of the northern woodland jumping mouse, *Napaeozapus insignis insignis* (Miller), was collected on the night of August 24th in a trap baited with bacon. It was caught at the edge of a mixed woods of oak, maple, birch, and aspen, and at a point where this merges with the grassy tundra east of Champlain Mountain. In this vicinity the woodland floor is densely covered with a heavy growth of wild rose, meadowsweet, and long grasses and is moderately damp. At the same location the Hudson Bay jumping mouse, short-tailed shrew, and Bonaparte weasel also were trapped.

On September 7, a C.C.C. supervisor (reported in Nature Notes from Acadia, vol. 3, 1934) caught 6 live, immature specimens of *Napaeozapus* in a woods about one mile northwest of the location indicated above. He reported that an adult together with 9 young had been seen.

Although *Napaeozapus* has been reported by Pope (The Maine Naturalist, Vol. 2, 1922) from Brunswick, Maine, a search of the literature fails to reveal any record of its having been taken on Mount Desert Island or in the region nearby, where in all probability it is uncommon.—M. Lelyn Branin, *John Carroll University, Cleveland, Ohio.*

NOMENCLATURE OF SOUTH AMERICAN HYSTRICOID RODENTS

Doctor A. Cabrera kindly has drawn my attention to several errors in my paper on the taxonomy of hystricoid rodents (Bull. Amer. Mus. Nat. Hist., vol. 68, art. 5, 1935), which I now wish to correct.

Caviella (l.c. p. 347) has been shown by Kraglievich (Physis, vol. 8, p. 593, 1927; Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 36, pp. 87–89, 1930) to be congeneric with the fossil *Microcavia* Gervais and Ameghino (Mamíferos Fosiles de la America del Sud, p. 50, 1880), with type *M. typus*, said to be indistinguishable from *australis*.

Dolichotis salinicola Burmeister (l.c. p. 356) was by Marelli (Mem. Jardin Zool. La Plata, vol. 3, p. 5, 1927) separated from *Dolichotis* under the generic term *Pediolagus* (type by original designation *Dolichotis centralis* Weyenbergh, 1877 = *D. salinicola* Burmeister, 1876). Shortly thereafter Kraglievich (Physis, vol. 8, p. 594, 1927) took similar action, proposing for *salinicola* the generic name *Paradolichotis*, which, of course, falls as a synonym of *Pediolagus*.

"*Capromys elegans* Cabrera" (l.c. pp. 372–373) was indicated by Cabrera himself (Trabajos Mus. Cienc. Nat. de Madrid, no. 3, p. 30, 1912) to be not a *Capromys* but really a *Phlaeomys*, probably from the Philippine Islands.—G. H. H. Tate, *American Museum of Natural History, New York, N. Y.*

AN ISOLATED COLONY OF THE GRAY-HEADED PIKA IN NEVADA

Pikas were noted in the rock slides along the crest of the Pine Forest Mountains, Humboldt County, Nevada on June 6 and 8, 1935. Three adults were taken at the edge of Duffer Peak Meadow, 8400 to 8600 feet, and others were heard a mile distant in talus slopes south of Duffer Peak. No localities in these mountains outside of the limited area above 8000 feet are known to me that would be suitable for pikas; nor does it appear that they existed in any part of the range explored by Taylor (Univ. Calif. Publ. Zool., vol. 7, pp. 319–436, 1912). The Pine Forest Mountains are well isolated by unfavorable desert regions from other areas where pikas occur. The nearest localities of record for the race *taylori* are in the Steens Mountains of Oregon, 45 miles distant, and the Warner Mountains of California, 75 miles distant.

Although one might expect examples from this hitherto unknown colony to resemble *taylori*, it is clear that they do not pertain to this form. The animals seem to me in-

separable from the gray-headed pika, *Ochotona princeps schisticeps* (*O. princeps* and *O. shisticeps* are considered to be conspecific). *Ochotona p. schisticeps* occurs in the Mount Lassen area 130 miles distant. The three specimens, comprising 1 male and 2 females, are in worn winter pelage. The heads are especially gray and in this regard they differ slightly from most specimens of *schisticeps* taken in June. In several cases, however, examples of *schisticeps* in strictly comparable pelage, without any traces of new brownish summer fur, are indistinguishable. All 3 have distinctly black ears with prominent white edges. In this respect they may be matched by a few *schisticeps*. Back coloration is identical with that of animals from Mount Lassen. The size is small as in *taylori*, but size difference in *taylori* and *schisticeps* is a matter of average, and the 3 individuals cannot be relied upon to indicate this feature of the population. No skull characters could be found to distinguish them from *taylori* or *schisticeps*. A good series from the Pine Forest Mountains possibly might reveal average differences that are not indicated in the material at hand. But in the absence of any easily perceived characters peculiar to these 3 specimens, the existence of differentiation of racial magnitude seems unlikely.

With this addition to the range of *O. p. schisticeps*, *taylori* of the Modoc area, in a sense, is surrounded on the east, south and west by lighter colored populations. To my mind, this accentuates the endemism of the dark colored *taylori* in the lava regions of northeastern California and adjacent parts of Oregon. Although the habitat of *taylori* may not be exclusively lava rock, the prominence of such formations within its range is apparent. The rock slides occupied by pikas in the Pine Forest Mountains are of fairly light colored granite.

In comparing other races of pikas, the markedly similar coloration of *fuscipes* of the Parowan Mountains, southern Utah, and *O. p. schisticeps*, was evident. A. H. Howell (North Amer. Fauna, no. 47, p. 47, 1924) in commenting on this similarity stated that the soles and palms of *fuscipes* are darker than in *schisticeps*. The reverse is true in the series available to me, and Howell (Proc. Biol. Soc. Wash., vol. 32, p. 110, 1919) in his original description of *fuscipes* said that the feet are fuscous. It is possible that the comparative statement (p. 47) inadvertently was reversed. The point is of some importance as it appears likely that a degree of affinity of *fuscipes* with the quite differently colored *cinnamomea* of a neighboring mountain range is indicated by the similar fuscous hue of the soles. The skulls of *fuscipes* appear to me to resemble *cinnamomea* as much as they do *schisticeps*. The dark dorsal coloration of *fuscipes* may be correlated with the dark basaltic rock which I have found prevalent in at least a part of the range of this race. It is not impossible that a stage in dorsal pigmentation closely similar to that of *O. p. schisticeps* has been attained by darkening in a lava area, independently of any immediate relationship with the Sierra Nevadan form.—ALDEN H. MILLER, *Museum of Vertebrate Zoology, Berkeley, California.*

FOOD HABITS OF LEPUS AMERICANUS PHAEONOTUS

Snowshoe hares of the race *Lepus a. phaeonotus* were collected from the disease study area at Cushing, Minnesota, the site of a coöperative project of the University of Minnesota and the Bureau of Biological Survey, and 54 of their stomachs were examined by Leon Kelso of the Food Habits Section, Division of Wildlife Research, Bureau of Biological Survey. Of these stomachs, 15 were taken in April and May, 10 in July and August, 20 in October, and 9 in December.

Analysis of the stomach contents of these hares presents a rather difficult problem owing to the fact that the food is chewed very finely. This makes difficult the positive identification of much of the material.

With a single exception the food consisted solely of vegetable matter. In one stomach, taken October 7, 1931, were found the remains of 2 adult and 1 larval *Lepidoptera*,

1 black ant (*Lasius*), 7 myrmicine ants (*Myrmica rubra*), 6 tobacco beetles (*Lasioderma serricorne*), and a leg fragment and egg case of an undetermined insect, all comprising only a trace.

Of the 15 stomachs taken in the spring, 90 per cent or more of the contents of 7 consisted of woody foods, such as *Populus tremuloides*, *Salix*, and *Betula;* 90 and 95 per cent, respectively, of 2, indeterminate herbaceous material; 80 per cent of 1, *Fragaria;* 90 per cent of another, *Antennaria;* and 80 per cent of a third, buds and bark that could not be identified. Small amounts of *Taraxacum*, *Trifolium*, *Equisetum*, *Fragaria*, and *Antennaria* were found in several of the stomachs.

In all but 2 of the stomachs, *Lepus* hair was present, ranging in quantity from a trace to as high as 15 per cent. In all but 1 the nematode worm, *Obeliscoides cuniculi*, was present, its numbers ranging in individual hares from 20 to as many as 250, and averaging 99 per hare. All stomachs were filled completely with food and other material, such as hair and traces of gravel.

The stomachs taken in summer contained chiefly such plants as *Trifolium* and *Antennaria*. The contents of 2 consisted mainly of *Salix*, and 1 was filled entirely with *Poaceae*. In all but 1, *Lepus* hair was present. Only half of the summer stomachs contained *Obeliscoides cuniculi*. Gravel comprised 5 per cent of the contents of one.

The stomachs of the snowshoe hares collected in the fall were filled largely with *Poaceae*. In 2 stomachs *Antennaria* was present, in 1, Leguminosae, and in another, a small quantity of *Lycopodium*. Small quantities of *Salix* and *Populus tremuloides* were found in three. One stomach contained a single *Obeliscoides cuniculi* and a trace of hair. As a lot, these stomachs were free from the nematode worms as well as from *Lepus* hair.

Examination of the stomachs of hares taken in the winter showed the contents to be composed almost entirely of *Salix*, and *Betula*, twigs, bark and buds. In only 2 were the contents largely of indeterminate herbaceous matter. All but 1 stomach contained *Lepus* hair, and 4 of the 9 showed the presence of nematode worms, the lowest number of the latter found in any one stomach being 1 and the highest, 110. Half of the stomachs were full, while the remainder were nearly empty.—C. M. Aldous, *Lake States Forest Experiment Station, University Farm, St. Paul, Minnesota.*

REVIEWS

Lyon, Marcus Ward, Jr. MAMMALS OF INDIANA. Reprinted from the American Midland Naturalist, vol. 17, no. 1, pp. 1–384, Notre Dame, Indiana, January, 1936. Cloth, $3.00.

It is a pleasure once more to receive a new and substantial publication by this author, and to find, as one naturally would expect, that it conforms to the same standard of meticulous thoroughness as his contributions of former years.

There are listed 69 forms of recent mammals from Indiana, and 14 of Pleistocene species. The synonomy, description, measurements, habits, and state history of the rarer sorts, as well as a state map showing county records, is given for each species. It is surprising to learn that deer and bobcats no longer occur within the state. Both exist within 30 miles of New York City. The relative paucity of Indiana's mammalian species may be attributed to the absence of marked physiographic features and a lack of climatic variation. While mammalogists assign the whole of Indiana to the Upper Austral, botanically the state has been divided into Transition, Upper, and Lower Austral zones. Lyon considers that the distribution of the recent mammalian fauna within the state is of little importance as a determinant of life zones.

The subject matter is conveniently arranged and quite profusely illustrated. Credit is given with liberality. An imposing list of 386 titles comprises all of the important publications on Indiana mammals, and many general works as well.

The book is one that will find constant use, not only by naturalists but by the insistent laity as well. Both the professional zoologist and the school child will profit by it. The author and all concerned are to be congratulated.—W. J. HAMILTON, JR.

Goodwin, George Gilbert. THE MAMMALS OF CONNECTICUT. State of Connecticut, Public Document no. 47. State Geological and Natural History Survey, Bulletin no. 53, 221 pages, 33 plates, 19 figures, October 19, 1935. Paper, $2.00.

It is not often that there is opportunity to review in a single number of the Journal two outstanding state reports on mammals.

The present contribution is a substantial volume, well printed and conveniently planned. Only two typographical errors, in the Latin names of cetaceans, were detected. There is given a table of classification, and adequate descriptions of all included species, in addition to general distributions, and ranges and records within the state. The general discussions are particularly interesting, and contain a wealth of information well worth the perusal of any mammalogist. The presentation of data relating to rare or extirpated species is a feature that is stressed, and one that should be accomplished for all states as speedily as possible.

At present there are 61 kinds of mammals that have been recorded from Connecticut, and in addition 38 are listed in the present report as likely prospects for the state. In a volume of the present character, intended for use both by professionals and interested school children, the latter feature not only is permissible but desirable. The plates, although a trifle gloomy in appearance, portray with particular accuracy the characteristics of the mammals illustrated, possibly excepting the opossum.—A. B. H.

LIST OF RECENT LITERATURE

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AFANASJEV, A., and N. ZOLOTAREV. Contribution to the systematics and distribution of the red wolf. Bull. Acad. Sci. URSS, ser. 7, no. 3, pp. 425–429. 1935. (New: *Cyon alpinus hesperius.* In Russian, with English summary.)

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and Live-stock in India, Delhi, vol. 4, pt. 3, pp. 275–286, figs. 4, pl. 35. May, 1934. (*Gunomys kok, Millardia meltada, Tatera indica.*)

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OBITUARY NOTICES

GEORGE MELENDEZ WRIGHT—ROGER WOLCOTT TOLL

George Melendez Wright, Chief, Wildlife Division, National Park Service, and Roger Wolcott Toll, Superintendent, Yellowstone National Park, both were killed in an automobile accident near Deming, New Mexico, February 25, 1936. At the time of their death they were members of a special commission, together with officials from Mexico, investigating the possibility of international parks and wildlife refuges.

Roger W. Toll, born in Denver, Colorado, October 17, 1883, received his early training at Denver University and was graduated in civil engineering from Columbia University in 1906. Having served with the U. S. Coast and Geodetic Survey in Alaska, with the Denver Tramway Company as Chief Engineer, as Major in the Ordnance Department of the United States Army during the World War, he was appointed Superintendent of Mount Rainier National Park, Washington, in 1919. From 1921 to 1929, he served as Superintendent of the Rocky Mountain National Park. In the latter year he was appointed Superintendent of Yellowstone. In this capacity he devoted particular attention to wildlife problems of the park and was a leader in the development of a more effective technique for the restoration and protection of natural ecological conditions. For many years he was official investigator of proposed national parks and monuments for the National Park Service, and frequently contributed from his own funds to make the inspections and reports comprehensive. Always an intelligent conservationist, with keen powers of observation and deduction, and with a broad scientific and cultural background, his influence in the establishment of biological sanctuaries was far-reaching.

An ardent mountaineer, he was a member of the first expedition to climb to the summit of Mount Rainier via the Kantz Glacier route. He published "Mountaineering in Rocky Mountain National Park," and "Mountain Peaks of Colorado." Because of his genial personality, and his recognized ability and broad attainments, he was loved sincerely by his fellow workers.

George M. Wright was born in San Francisco, June 20, 1904. His mother was a member of the Melendez family of San Salvador, and his father's family was among the San Franciscans of 1849. He obtained his early education in the public schools, and graduated from the University of California, College of Forestry, in 1927. While studying forestry, he accompanied Joseph S. Dixon, at that time economic mammalogist of the University, on an expedition to Mount McKinley, Alaska, where he discovered the nest of the surf bird.

After graduating, he held positions as ranger and junior park naturalist in Yosemite National Park. On July 1, 1929, he undertook, at his own expense, a reconnaissance of the National Park System: (1) to analyze and delineate the existing status of wildlife in the parks; (2) to assist park superintendents in solving urgent animal problems; and (3) to develop a well-defined wildlife policy for the National Park System. The results were published in "Fauna of the National Parks," volumes 1 and 2.

The Wildlife Division of the National Park Service formally was established May 3, 1933, with Wright designated as Chief. He held that position until his death, ably directing all activities pertaining to conservation of park wildlife and assisting in the solution of national wildlife conservation problems in general. In addition to the Fauna series, he contributed scientific articles and notes to The Condor, Journal of Mammalogy, The Scientific Monthly, the National Park Service Nature Notes series, and more popular accounts to various newspapers. He had the happy faculty of infusing into his writings, as well as into his contacts, an intellectual discipline and a vitality which were his own personal contribution.

Characteristic of his written expression is the following: "More of the wild animal background should enter into wildlife administration to the exclusion of ideas rooted in centuries of association with domestic livestock."

George Wright served on the Economic Mammalogy Committee of the American Society of Mammalogists, from 1931 to 1936, inclusive, and was Chairman of the Life Histories and Ecology Committee during 1935 and 1936. He also was a member of numerous scientific and conservation organizations.—HAROLD C. BRYANT.

KARL B. HANSON

Karl B. Hanson, a member of the American Society of Mammalogists since 1921, died on January 9, 1936, from pneumonia. He was born in Chicago, Illinois, March 10, 1893. He received his elementary and college preparatory education in the schools of Washington, D. C. and was graduated from the high school at Hyde Park, Illinois. In 1916 he received the degree of Bachelor of Science from the University of Wisconsin, and in 1919, that of Doctor of Veterinary Medicine from Michigan Agricultural College. At the latter institution he was made a member of Alpha Psi, the honorary veterinary fraternity.

He was married to Katherine M. McAloon of Keeseville, New York, who survives him, as do his parents, Dr. and Mrs. J. C. M. Hanson of Sister Bay, Wisconsin.

Hanson was director of the Biological Survey Fur Animal Experiment Station, Saratoga Springs, New York, from 1919 to 1935. He resigned this position on January 5, 1935, to become a ranch veterinarian and research specialist for Fromm Brothers, a large fox-farming company. He made several important research discoveries that have been of great value to the fur-breeding industry, among which were the discovery that the marten breeds in summer, the determination of the manner in which the red, silver, black, and cross fox color phases in foxes are inherited, the development of practical treatments of the common parasitic diseases of the fox, and valuable information concerning contagious diseases in foxes and other fur-bearing animals.—VIOLA S. SCHANTZ.

CORRESPONDENCE

Editor, Journal of Mammalogy:

In the JOURNAL OF MAMMALOGY for November, 1935 (vol. 16 pp. 323–324), is an article by Carl O. Mohr entitled "Value of prey-individual analysis of stomach contents of predatory animals." This is the most recent of several aspersions on the volumetric system of stomach analysis, all of which are characterized by some degree of misconception.

In the first place volumetric analyses as ordinarily carried on by the Biological Survey (where most of this work is done), have included, so far as is possible, counts of individuals of the food species. Thus data are available for discussion from the standpoint of both numbers and volume. Whether Mohr refers to predators in a narrow sense is uncertain, but it may well be pointed out that it would be unfortunate to adopt a strictly numerical system of food-habit study for a certain group of animals when the volumetric system is the only one that is practicable for others. We may refer here to the general run of rodents which grind their food so finely that accurate counting of the individual items represented for the most part is impossible. In fact, certain kinds of food eaten not only by rodents but by other animals rarely are susceptible of enumeration. Comminuted tubers, roots, herbage, browse are cogent examples, and even fruits often cannot be counted because the consuming animal rejects a part or all of the seeds.

These foods may not appear to be those of predators but Mohr mentions some of them and admits the necessity of using bulk measure for them. As comparisons are impracticable if we use the numerical method for some of the animals studied and the volumetric for others, so also it is meaningless to estimate part of the food of any animal by volume if the bulk of other portions of the diet of the same species remains unknown—as it would, unless the volumetric system were applied throughout. Moreover, most animals are mixed feeders, taking some of the uncountable items along with others more readily dealt with numerically.

As related strictly to predatory forms, it is evident that counting is not applicable to food taken on return visits to a kill, to that shared by a number of adults, nor to that divided among a litter or brood of young. Most predators feed more or less on carrion, another item for which enumeration is impracticable, and for which it would be meaningless even if practicable. In fact, for predators on forms larger than those that can be swallowed whole, the numerical system can have only a partial and uncertain application, as many a meal may consist of flesh, skin and other parts of a kill not subject to enumeration.

Apparently in every new group of students of animal food habits arise critics of the volumetric system of food analysis. They seem quite oblivious to the fact that the merits of all possible systems have been weighed and discussed for decades, and that the prevailing practice was adopted for good and sufficient reasons. The writer reviewed the matter in 1912 (Auk, vol. 29, pp. 449–464, 1922), presenting both sides of the arguments that had been made up to that time. The conclusion reached was that since only the volumetric system can be applied in the case of some animals, and to certain important classes of food, it should be used in all in the interests of comparable results. Supplementary use of the more limited numerical system was recommended, and the point emphasized that it is not the method of computing or expressing results that is vital, but the accurate interpretation of them.

Mohr stated "as a matter of fact (when it is one only of opinion) a knowledge of the number of individuals of each species eaten is of greater scientific and economic value than a knowledge of the volume composed by each." In further concluding that economic status is "measured by individuals or activity of individuals" he overlooked the fact that the primary reason for studying food habits of animals is to learn more about

their relations to agriculture, and that the "activity of individuals" in that field almost invariably is expressed in terms of volume, as bushels, tons, and carloads. Bulk percentages of food thus are just what is needed for coördination with estimates of agricultural gains or losses.

The customary manner of reckoning the yield of fish ponds is in pounds per acre, and the production of other forms of wildlife can be computed in the same way (Alexander, Jour. Animal Ecol., vol. 1, pp. 58–64, 1932). It well may be that carrying capacity of a unit area is for a combined quantity of wildlife, rather than for a certain number of individuals. The fact is significant that in the case of game birds the known carrying capacity of an area for a single species is divided among a plurality of other species of about the same habitat requirements.

Individuals, in fact, always have a quantitative significance, and it is not a bad generalization that economic importance tends to be in proportion to size. So far as this is true, bulk measurements form a good basis for statements regarding economic tendencies. To repeat; it is not the symbols used in describing the food habits of animals that are illuminating, but the interpretation of their meaning in the story of life, taking into account all pertinent circumstances and information.

In conclusion, it must not be forgotten that among the objectives of food habit studies is the determination of the dietary requirements of animals, certainly a function of bulk, not of numbers. I must indicate, in addition, that Mohr is unjustified in citing any of Forbes' work as supporting the numerical system. Forbes advocated the volumetric method and by force of example and argument established it as the standard practice, not only in his time and country but for all subsequent periods to date, and for the world.

W. L. McAtee,
Bureau of Biological Survey,
Washington, D. C.

Editor, Journal of Mammalogy:

I have been afforded an opportunity to reply to the preceding communication by Mr. McAtee, commenting upon a recent note of mine in the Journal of Mammalogy (vol. 16, pp. 323–324, 1935).

When this note was written, reports on stomach analyses of predatory mammals generally were based on percentages by volume, or percentage of stomachs containing given classes or species of food, but not on numbers and percentage of individuals eaten. It seemed that thousands of predators were being accumulated at great expense of time and labor only to have this important information ignored or concealed in notebooks.

In short, the note was written to stimulate production of studies and reports analyzing the numbers eaten, but not to condemn volumetric analysis. I quote from the note: "Most vegetable material, carrion and inorganic material may be analyzed by bulk . . . and compared with the total bulk of other (those that can be counted) food items."

If McAtee's words can better stimulate such studies, I wish to isolate one item from his writings. "The ideal system . . . is one that combines the good points of both the numerical and volumetric methods—a system which, as a matter of record, counts individuals as far as possible, . . . and which further estimates the proportion of all important items by bulk" (Auk, vol. 29, p. 464, 1922).

Some important trail-blazing took place before my note appeared in print: Errington (Jour. Mamm., vol. 16, pp. 192–200, 1935) analyzed the prey of Iowa and Wisconsin foxes by number, and O. J. Murie (U. S. Dept. Agric. circ. no. 362, 24 pp., 1935) analyzed that of coyotes in the same way. It is significant that both studies were accompanied by new and important conclusions.

Carl O. Mohr,
Illinois Natural History Survey,
Urbana, Illinois.

COMMENT AND NEWS

During the past four years, Donald R. Griffin, Barnstable, Massachusetts, has been working intensively on the project of banding bats, and already has marked 2500 individuals, of five species. This is a most promising field for investigation, and the results should be of cumulative interest. Mr. Griffin particularly is desirous that everyone in the northeastern United States who is in a position to examine live bats, shall search for banded individuals, and advise him if any be found. In order to extend these studies he would appreciate notification regarding any occupied caves and summer colonies in this region that may be known to members of the Society.

An expedition, organized and led by Richard Archbold of the American Museum of Natural History, left New York on January 24, 1936. G. H. H. Tate is mammalogist of the party, and the destination is the upper reaches of the Fly River and the adjacent mountains of South New Guinea. It is planned to spend nine months in this region.

In addition to the fact that collecting will be done in one of the least known parts of the world, the project is of particular interest because of the fact that a new technique will be employed. The expedition is equipped with airplane and radios. The back country will be penetrated by a ground party with the barest necessities. Communication with headquarters will be maintained by radio, and the airplane will keep the field party supplied with everything necessary, equipment being delivered by means of small parachutes. In this manner it is hoped in months to accomplish results that otherwise would require years.

James L. Clark, of the American Museum, and Max C. Fleischmann, of Santa Barbara, California, sailed from San Francisco, February 21, 1936, on a joint expedition whose destination is the interior of Indo-China. Particular attention will be paid to small mammals, as well as to big game varieties, and an extensive series of photographs will be sought.

The Society is indebted to the American Committee for International Wild Life Protection for financial aid toward the publication of the article by Dr. Cabrera in this number of the Journal of Mammalogy. The cost of most illustrations also has been defrayed by the authors or the institutions with which they are connected. These acts of generosity merit the appreciation of the entire Society, for it is only in this manner that the size of the Journal can be increased at the present time.

The above facts introduce the question of the propriety of publishing subsidized papers. The only possible valid objection to this course lies in the danger of special privilege. The latter hardly can apply to an instance where the entire publication cost is contributed to the Society. Any objectionable feature lies in the possibility that an editor may be tempted to accord precedence to a subsidized paper, thus favoring the author of means and displacing articles written by those who are not in a position to aid financially toward publication.

The whole question depends upon the integrity of the editor. If he be lax in this respect, authors will have grounds for real grievances on the charge of unfairness; if he be properly impartial, authors in no wise will have cause for complaint, and the readers of the Journal will be benefited. Under the present editorship, partially subsidized articles will have no precedence over other sorts.

It is not always possible, however, to publish papers in the precise order in which they are accepted. Each number of the Journal is built upon a foundation of the papers that have been longest on file; but that is all that can be said. The editor might have on hand enough papers on a particular technical subject to last a year, while at the same time there was a dearth of articles of a general nature. In that circumstance, obviously,

the same number might contain one paper whose publication had been deferred for many months, and another received but a short time before going to press.

A field party, headed by Dr. Seth B. Benson, left the Musuem of Vertebrate Zoology, Berkeley, California, for northwestern Mexico on March 10. Three months will be spent, mainly in the states of Sonora and Chihuahua, with the chief objective a field study of the rodent genus *Perognathus*, as well as the collecting of topotypic material.